K4OG/WB4RHH
CHES. WATKINS
P. O. BOX 3268
FT. PIERCE, FLA. 33450

INSTRUCTION MANUAL

TYPES 200, 300 and 350
SPECTRUM DISPLAY UNITS

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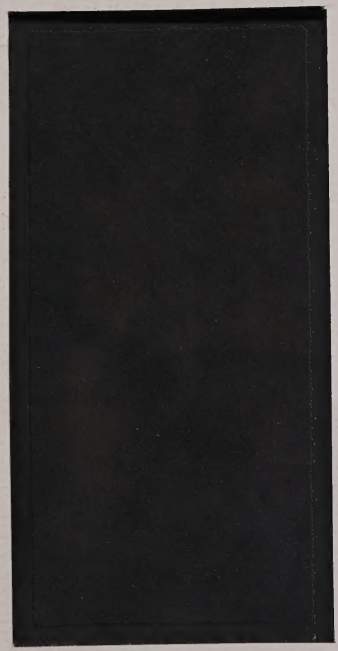
Defense Electronics
DIVISION OF DEI INDUSTRIES
producers of DEI and NEMS-CLARKE equipment



NEMS CLARKE
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1971

Defense Electronics, Inc.
PRODUCERS OF
DEI AND NEMS-CLARKE
EQUIPMENT

DEI
RESEARCH
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Rockville, Maryland 20854

WARNING

Extreme High Voltage, 1630 vac. Exercise caution while working in the Spectrum Display Units.

Foreword

The spectrum display units considered in this instruction book all have the same function: cathode-ray-tube presentation of an expanded frequency spectrum (bandwidth) that is characteristic of any one of approximately fifty-six diverse telemetry receivers. The diversity of receivers leads to a similar diversity of spectrum display units. For example, the spectrum display units are grouped according to similarities into four subtypes.

Subtype A
SDU 200–1, 200–2, 200–7, 300–1, 300–2, 300–4, 300–6

Subtype B
SDU 200–3, 300–3

Subtype C
SDU 300–5

Subtype D
SDU 350–6, 350–7, 350–8

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Minor electrical differences among subtypes A, B and C are entirely confined to the input stages of the SDU. However, the differences between the composite subtype group A, B, C, and the single subtype D are major and involve the SDU as a whole.

For information on a specific SDU, the reader should first consult the Table of Contents.

The user of this manual should always inspect the rear cover pocket for addenda or errata concerning the particular SDU type in question. In addition, information covering new SDU types will be included in the pocket.

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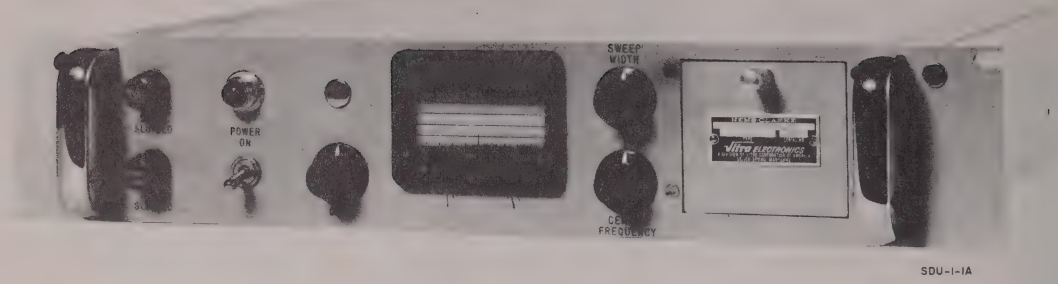
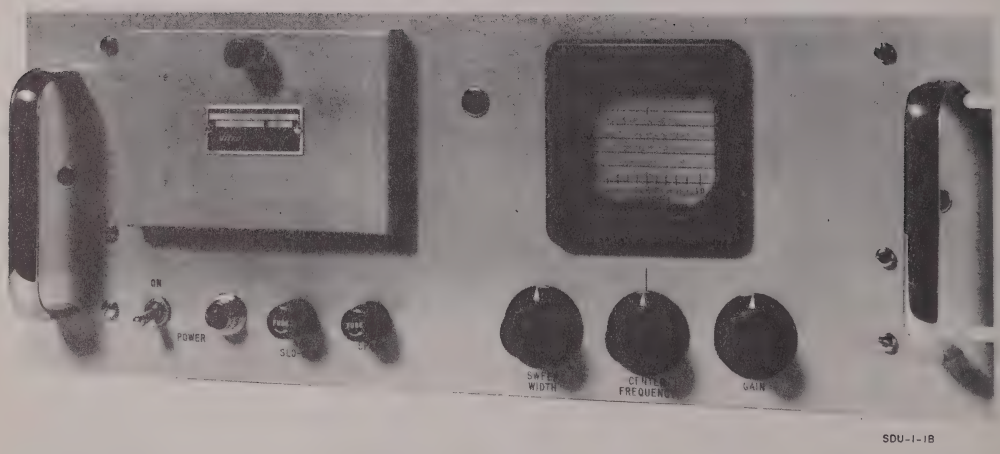
Table 1–1. *List of Nems-Clarke Special Purpose Receivers and Associated Spectrum Display Units*

Receiver Model Number	SDU Input Frequency	SDU type and frequency compensation suffix		
		Type 200	Type 300	Type 350
1301, 1301–A	21.4 mc	200–2	300–2	
1302, 1302–A	21.4 mc	200–2		
1306	21.4 mc	200–6	300–6	350–6
All model Numbers from 1400 to 1456BS	30.0 mc	200–3	300–3	
1403		200–3 (203)*	300–3	
All Models from 1500 to 1512	21.4 mc	200–2		
1670–E, 1670–F	21.4 mc	200–1	300–1	
1670–G, 1670–J	21.4 mc	200–2		
1671, 1672	21.4 mc	200–1	300–1	
1673, 1674	21.4 mc	200–2		
1701–A, 1702–A	21.4 mc	200–2	300–5	
1906, 1907	21.4 mc	200–7		350–7
2100, 2100–A	21.4 mc		300–4	
2301, 2301–A	21.4 mc	200–2		
2302	21.4 mc	200–2		
2401	21.4 mc	200–2		
2701	21.4 mc	200–1		
2801	21.4 mc			350–8

*SDU Model 203 used in airborne applications.



a. Type 350



b. Types 200 and 300

Figure 1–1. Spectrum Display Units, Front View

Chapter 1
General Description

1.1 GENERAL.

The spectrum display unit, designated simply SDU, is a versatile heterodyning receiver that displays signals from an associated telemetry receiver(s) on a cathode ray tube (CRT). Front panel views of the equipment are shown in Figure 1–1; performance specifications are listed in Table 1–2. The combined SDU receiver response curve width is 2 mc or 3 mc centered about a vertical deflection (received input frequency) at the midpoint of the CRT trace. Other signals simultaneously accepted by the telemetry receiver, even below the usual 3-db points on the receiver response curve, appear as vertical deflections (pips) removed left and right from the midpoint of the trace by a distance that is proportional to their frequencies.

1.2 USE.

The various spectrum display units are designed for use with specific telemetry receivers (tab. 1–1). The operator is able to selectively monitor any one of four associated telemetry receivers by means of an optional receiver selector switch mounted on the SDU front panel. The CRT presentation permits continuous surveillance and rapid monitoring of all signals within the combined bandwidth of the SDU and the receiver, and the receiver tuning range. Thus, signals of short duration, undulating amplitude, and changing frequency, that appear at the extremities of the receiver bandwidth and that ordinarily escape detection and analysis, can be detected and analyzed with a rapidity that is limited only by the skill of the operator and the speed with which he can tune the active receiver(s). After selecting a signal to be monitored, the operator excludes undesired signals by expanding the CRT presentation with a SWEEP WIDTH control. This control allows the operator to change from wide band spectrum surveillance to narrow band signal inspection and conversely.

1.3 PHYSICAL CHARACTERISTICS.

Excepting SDU type 350, all other SDU types are similar in external physical appearance. SDU types 350 are miniaturized versions of the standard SDU types, 200 and 300. The front panel of SDU type 350 is reduced from the standard height of 7 inches to 3.5 inches and the front panel controls are placed left and right of the CRT screen (fig. 1–1a). The front panel controls of SDU types 200 and 300 are mounted directly under the CRT screen (fig. 1–1b). Both standard and miniaturized SDU types are equipped with rigid, perforated dust covers and all SDU types accommodate NEMS-CLARKE SMT–100, side-mounted, bracket-slide assemblies as optional equipment. These assemblies allow the SDU to be serviced in a convenient attitude of either 45 or 90 degrees displacement from the horizontal after the SDU is withdrawn from the standard 19-inch equipment rack.

1.3.1 Front Panel. The following operating controls are mounted on the front panel: SWEEP WIDTH, CENTER FREQUENCY, GAIN, and a toggle POWER switch. Other features include a power light, a 1 AMP SLO-BLO fuse and SPARE, and an optional RECEIVER 1 2 3 4 selector switch. SDU type 350 displays two operating fuses, an 0.5 AMP SLO-BLO and a 1 AMP SLO-BLO with one space each clamped to the back of the flush-mounted, hinged cover that

Table 1–2. *Spectrum Display Units, Performance Specifications*

Maximum Sweep Width	
Type 200	2 mc
Types 300 and 350	3 mc*
Sweep Rate	30 cps
Input Frequency	21.4 mc or 30.0 mc, depending on type.
IF Amplifier Frequency	4.3 mc
Sensitivity for Full Deflection	5 microvolts to receiver
Signal Resolution	20 kc**
Power Input	
Types 200 and 300	115 vac, 50–60 cps
Type 350	115 vac, 50–60 cps, or 230 vac, 50–60 cps
Receiver Selector Switch (coaxial) for SDU	
Types 200 and 300	SWK–100
Type 350	SWK–101
Dimensions	
Length	13 inches
Width	19 inches
Height	
Types 200 and 300	7 inches
Type 350	3.5 inches
Weight	
Types 200 and 300	23 lb
Type 350	24.5 lb

*Sweep width of SDU–350–7 is 2 mc.

**Two equal-amplitude signals 20–kc apart appear as two separate pips with the point of intersection being at least 6 db down.

conceals the CRT-image adjustments. The sub-panel adjustments (fig. 1–2) located under the hinged cover at the upper left corner on the SDU front panel of types 200 and 300, and at the right extreme on the SDU front panel of type 350, are: six screwdriver adjustments labeled V POS, H POS, H GAIN, SWEEP, ASTIG, SYNC, and two manual controls, FOCUS and INT.

1.3.2 Rear Panel. All signal and power connections to the SDU are made at the rear panel, (fig. 1–3). A type BNC coaxial connector is used for the signal input. A twist-lock receptacle with a grounding terminal is used for the power input. An optional item that may be mounted on the rear apron is the SWK–100 or SWK–101 Switch Kit Assembly (fig. 1–4) that permits feeding any one of four telemetry receiver signal inputs to the SDU. A front panel control, RECEIVER 1 2 3 4, connects to the SWK–100 or SWK–101 coaxial switch by a long shaft. In addition, the type 350 SDU possesses a 2-position, bar-lock, power selector switch that enables the SDU to be operated from 115 vac or 230 vac power source.

Table 1–3. *Semi-Conductor and Tube Complement Types 200 and 300*

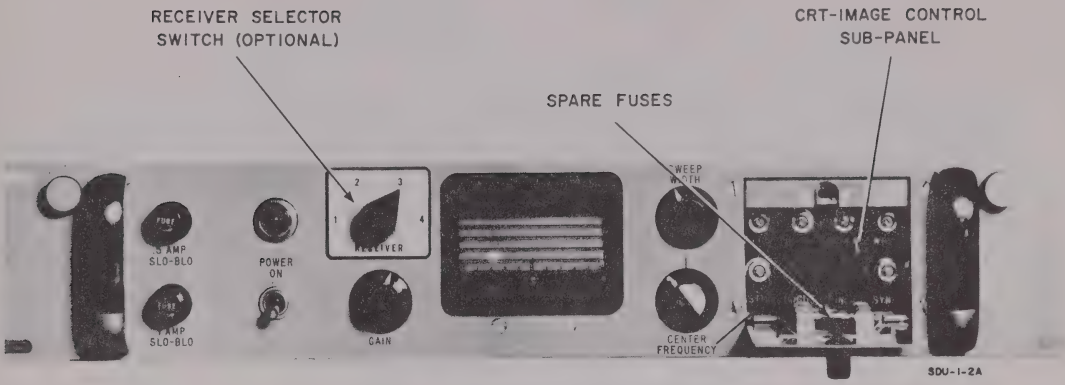
Circuit Symbol	Type	Function
CR–101, 102	026–30H–QC	B–Minus Rectifier
CR–201	CK–705/1N66	Detector
V–101	5Y3GT	B–Plus Rectifier
V–102	OA2	Voltage Regulator for IF Amplifier Oscillator and Reactance Modulator and Mixer.
V–103	OA2	Voltage Regulator for Preamplifier, Sweep Voltage Generator and Horizontal Deflection Amplifier.
V–104	12AU7	Horizontal Oscillator; Cathode Follower
V–105	12AT7	Horizontal Amplifier
V–106	3RP1A	Cathode Ray Tube
V–107	12AT7	Vertical Amplifier
V–201	6BA6	1st Preamplifier
V–202	6AU6	2nd Preamplifier
V–203	6AU6	Test Amplifier
V–301	6AH6	Reactance Modulator
V–302	6AU6	Sweeping Oscillator
V–303	6BE6	Mixer
V–401	6BA6	1st IF Amplifier
V–402	6BA6	2nd IF Amplifier
V–403	6AU6	3rd IF Amplifier
V–404	6AL5	Detector

Table 1–3. *Semi-Conductor and Tube Complement—cont. Spectrum Display Units Type 350*

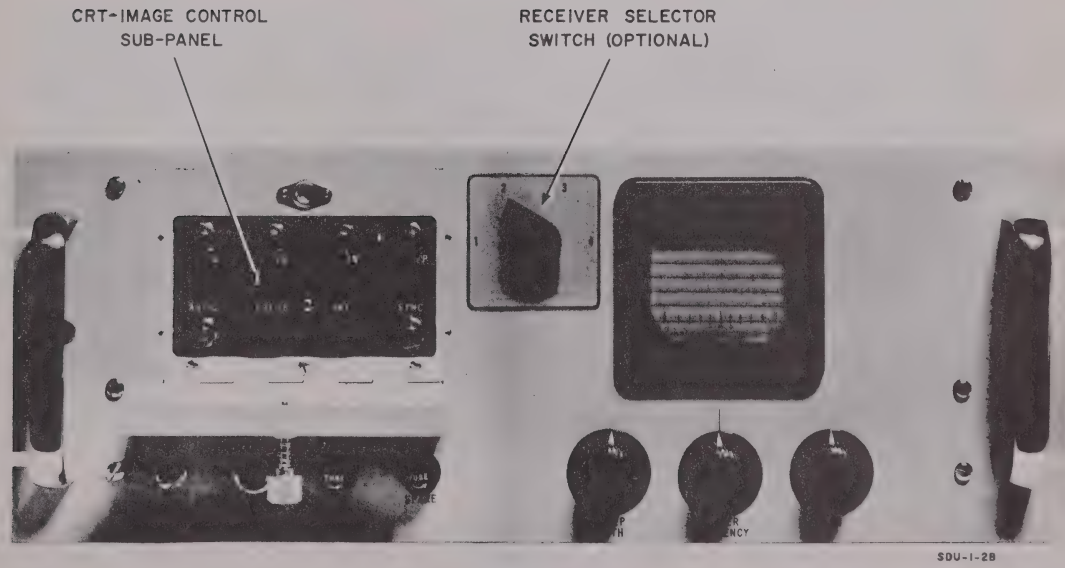
Circuit Symbol	Type	Function
CR–101, 102 103, 104	1N1695	B–Plus Rectifiers
CR–105	10M150Z5	Voltage Regulator
CR–106, 107, 108, 109, 110, 111	1N1697	B–Minus Rectifiers
CR–201	CK705/1N66	Detector
CR–301	1N661	Detector
V–101	5670	Horizontal Oscillator; Cathode Follower
V–102	5670	Horizontal Amplifier
V–103	5670	Vertical Amplifier
V–104	3XP1	Cathode Ray Tube
V–201	6BA6	1st Preamplifier
V–202	6AU6	2nd Preamplifier
V–203	6AU6	Test Amplifier
V–301	6AH6	Reactance Modulator
V–302	6AU6	Sweeping Oscillator
V–303	6BE6	Mixer
V–304	6BA6	1st IF Amplifier
V–305	6BA6	2nd IF Amplifier
V–306	6AU6	3rd IF Amplifier

1.4 SDU DIFFERENCES.

The versatility of the various SDU types is shown in Table 1–1. The basic SDU–200–1 may be factory modified to complement any receiver or receiver series by substitution or modification of the SDU preamplifier subchassis and readjustment of sweep width. As explained in the Foreword, SDU's are grouped into four subtypes according to similarities. However, the individual SDU's in any one subtype, although similar, are not identical. The subtypes are easily comparable from Figure 5–1, a composite schematic diagram of all SDU preamplifiers. Electrical differences between

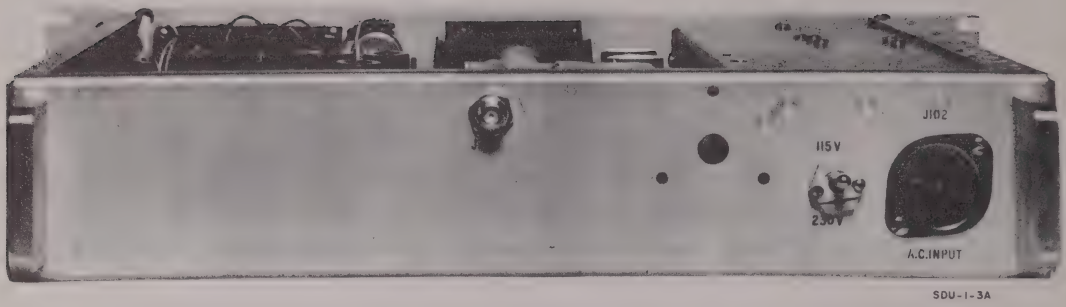


a. Type 350

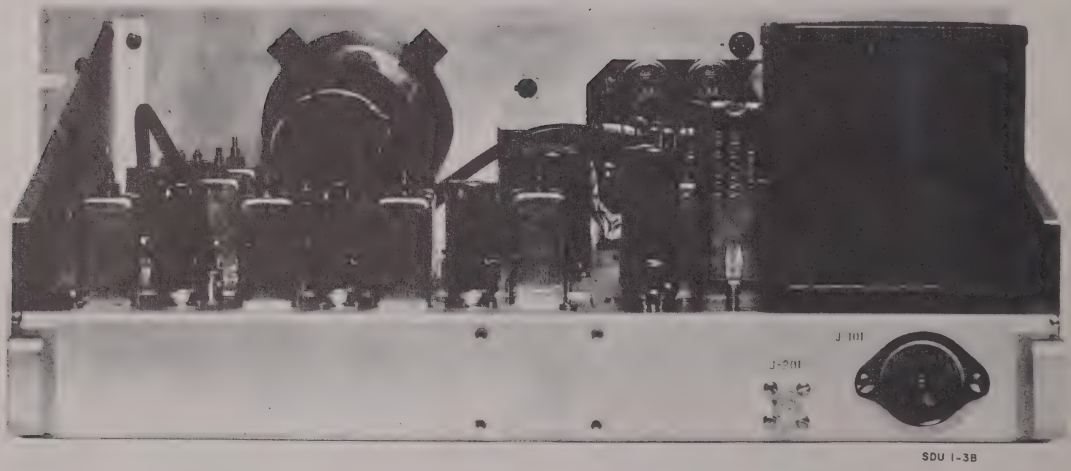


b. Types 200 and 300

Figure 1–2. Cathode Ray Tube Control Panel

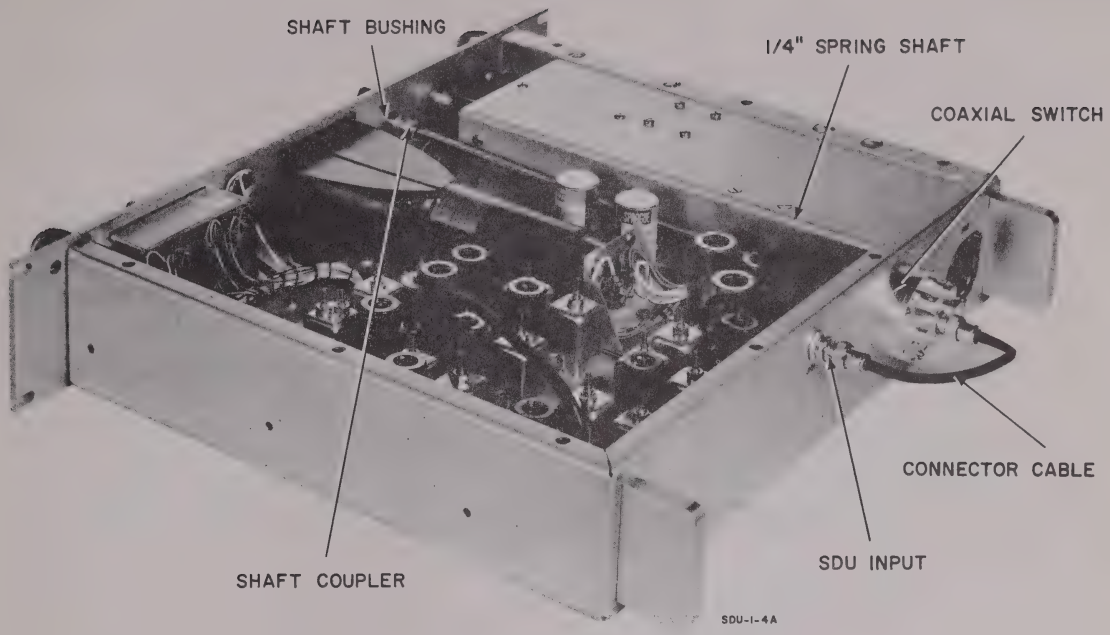


a. Type 350

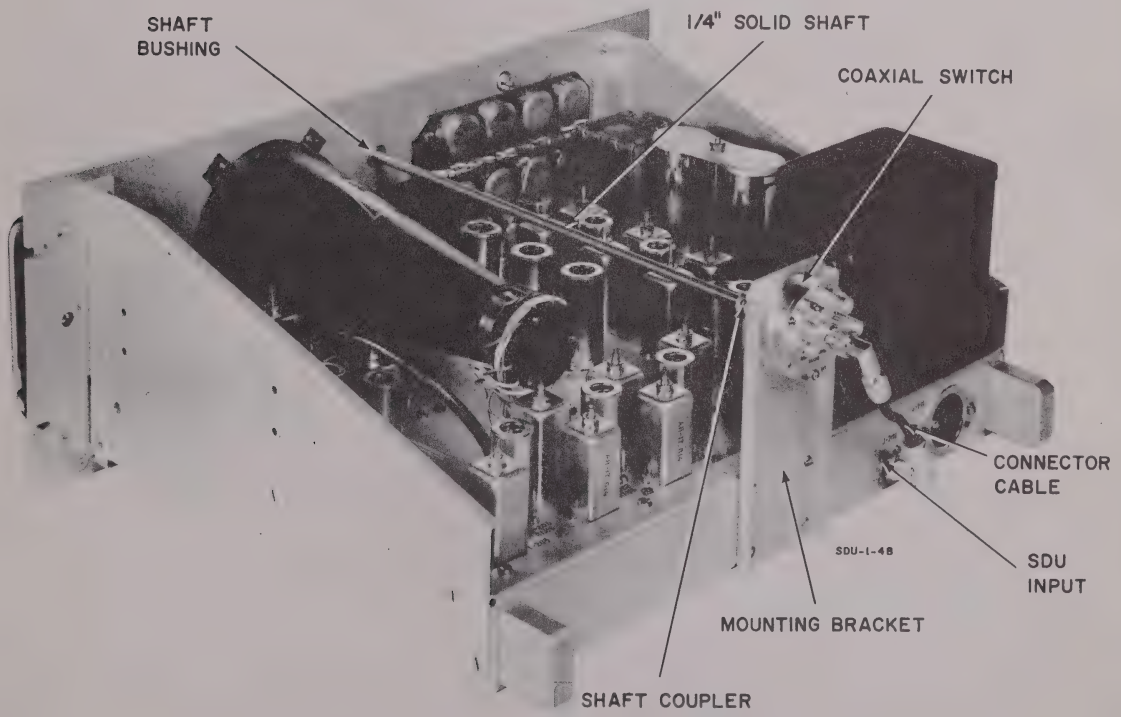


b. Types 200 and 300

Figure 1–3. Rear View

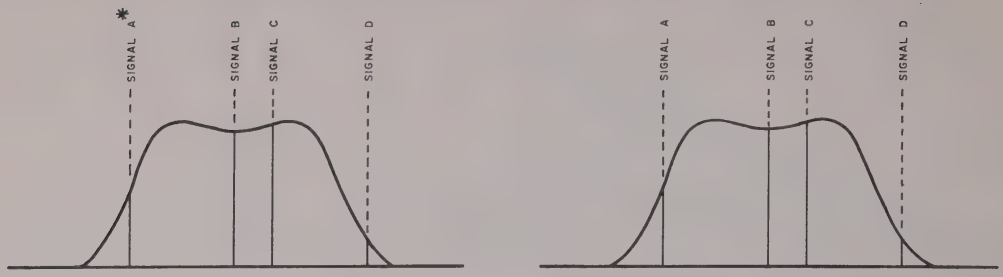


a. SWK-101 Switch Kit Mounted on SDU Type 350

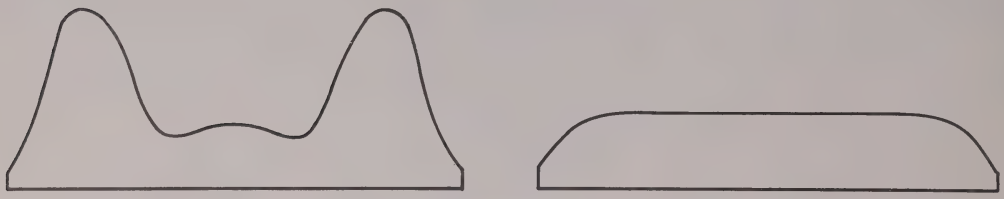


b. SWK-100 Switch Kit Mounted on SDU Types 200 and 300

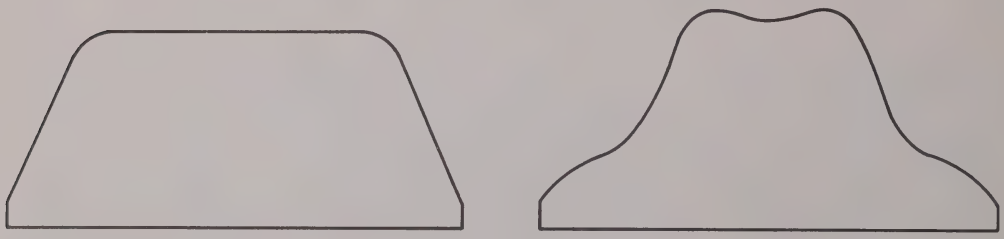
Figure 1–4. Optional Coaxial Switch Assemblies



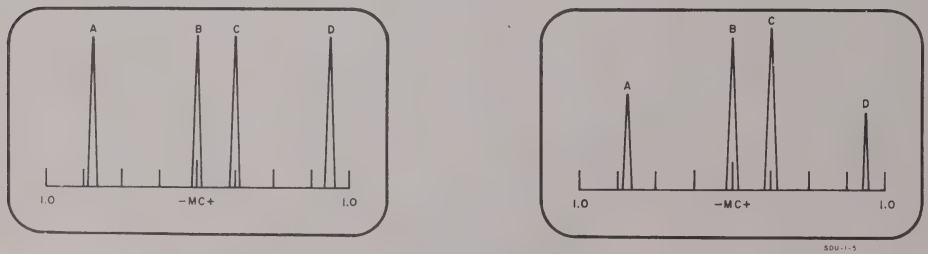
a. Receiver Response



b. SDU Response Compensated (left) and Uncompensated (right)



c. Resultant Response Curves



d. CRT Presentations

* SIGNALS A, B, C, AND D REPRESENT RF CARRIERS AT THE INPUT OF THE RECEIVER, ALL OF EQUAL AMPLITUDE.

Figure 1–5. Effect of SDU Frequency Compensation, Simplified

components and component values in the SDU types are indicated on the schematic.

1.5 FREQUENCY COMPENSATION.

The variation in subtypes and their numbers is a function of frequency compensation. Tuning of the active receiver during wide band spectrum surveillance causes the signal spikes to move laterally along the CRT trace. In order to maintain a uniform signal amplitude at constant signal strength, the mean frequency response of the telemeter-SDU combination must be flat; otherwise, the signal amplitudes change as they move along the CRT trace. Since the response of the RF, mixer, and IF stages in the receiver cannot be compensated without altering normal performance, the SDU is compensated by component value change and exclusion or inclusion of additional components in the input circuits, namely the preamplifier. The effect of frequency compensation is shown in Figure 1–5. Note the difference in the response curves for the compensated SDU and the uncompensated SDU. The former reflects an expanded and inverse copy of the RECEIVER RESPONSE; the latter is a random response curve and offers no intended compensation. When the compensated SDU response and receiver response are effectively combined, as in a telemeter-SDU hookup, the resultant is a symmetrical and flattened mean expanded response that extends ± 1.5 mc or ± 1.0 mc either side of the center frequency. SDU types 300 and 350 have a sweep width of ± 1.0 mc. The CRT presentation of receiver signals A,B,C and D by the compensated SDU is an accurate reproduction of the input signals to the receiver. The CRT presentation of these same signals by the uncompensated SDU are amplitude distorted, and, as the companion receiver is tuned, signals A through D appear to change amplitude as they traverse the CRT trace.

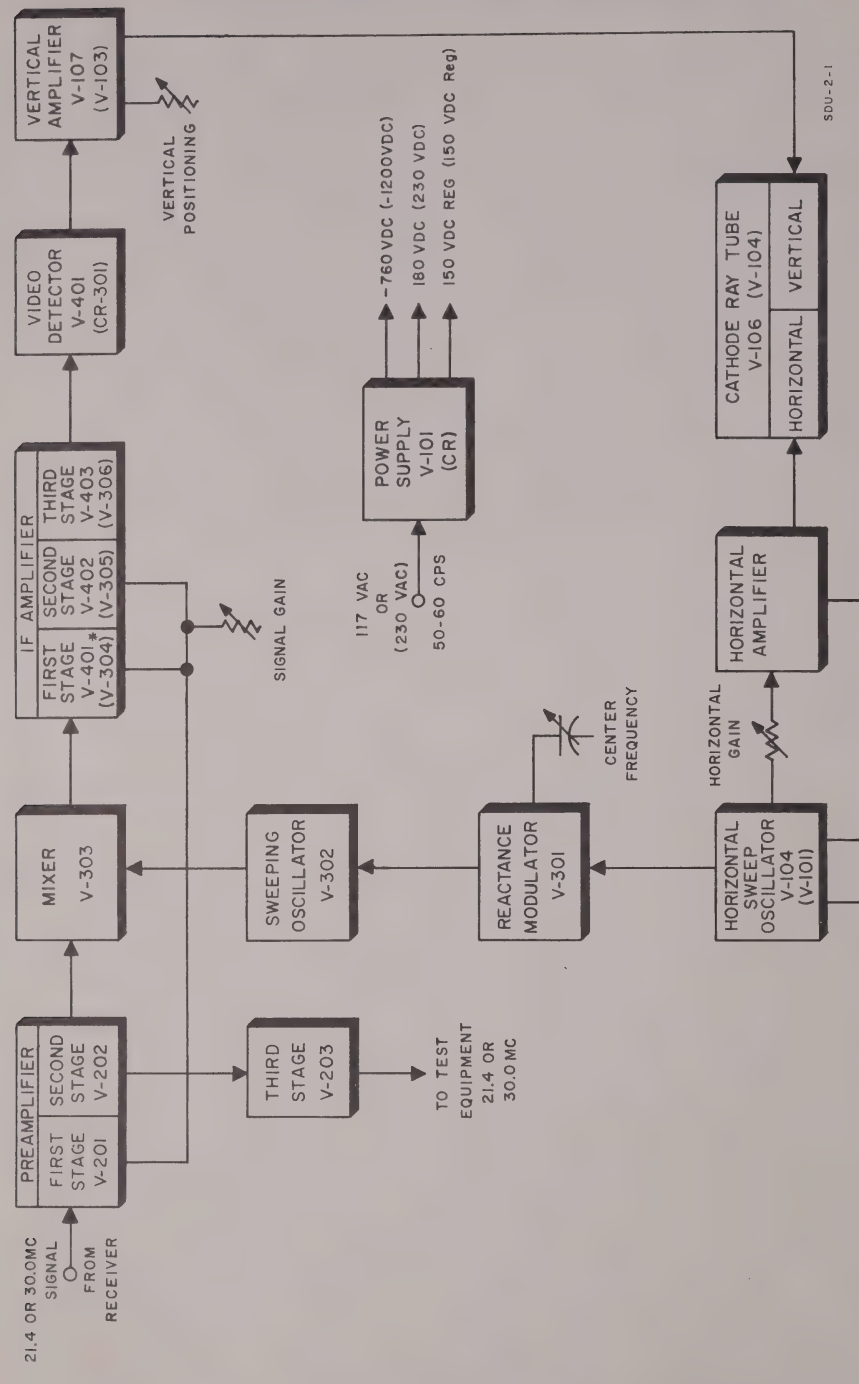


Figure 2–1. Composite Block Diagram

Chapter 2
Theory of Operation

Section I. Introduction

2.1 GENERAL.

The theory of operation of the various SDU types is presented in this chapter. A block diagram and simplified schematics are included to aid in the explanation of certain circuits. In addition, the reader should refer to the Composite Schematic Diagram of SDU Preamplifiers (fig. 5–1) and the Schematic Diagrams of the Main Chassis (fig. 5–2 and 5–3) as necessary.

2.2 BLOCK DIAGRAM ANALYSIS.

The SDU operates on the heterodyne principle and, lacking an audio frequency output, applies video signals to the vertical plates of a cathode ray tube for a panoramic and spectral presentation. Refer to Figure 2–1 Block Diagram, Combined Spectrum Display Units, for the various stages discussed. Signals are fed to the SDU from an early stage in the telemetry receiver such as the mixer or first IF amplifier; the exact point of sampling varies between receiver models. These signals at and near an IF center frequency of 21.4 or 30.0 mc, depending upon the receiver type, constitute the input to the SDU. The receiver signals are amplified, mixed with the frequencies produced by the SDU sweeping local oscillator, and the difference frequency of approximately 4.3 mc is amplified by a three stage IF amplifier. The signals are detected and fed to a vertical amplifier that controls the vertical deflections on the CRT trace. The horizontal CRT deflections are synchronized with the sweep repetition rate of the local oscillator, so that a reference is achieved between signals in the active frequency spectrum and their presence horizontally on the CRT trace.

2.3 SUBTYPE GROUPING.

For the sake of convenience in preparing this manual, the various SDU's are combined into subtypes as follows:

Subtype A	SDU types 200–1, 200–2, 200–7, 300–1, 300–2, 300–4, and 300–6.
Subtype B	SDU types 200–3 and 300–3.
Subtype C	SDU type 300–5.
Subtype D	SDU types 350–6, 350–7 and 350–8.

Section II. Subtypes A, B, and C

2.4 PREAMPLIFIERS.

A three stage, frequency compensated preamplifier accepts the receiver IF plus all signals within a maximum bandwidth of ±1.5 mc. After two stages of amplification, the spectral frequencies are fed to both a mixer stage and to a third stage of amplification. The rectified output of the third amplifier provides source signals to auxiliary test equipment.

2.4.1 Subtype A, First Stage. Input to the preamplifier is taken from an SDU output jack on the telemetry receiver. The signals fed to the SDU output jack originate in either the first converter or first IF amplifier stage in the receiver. The 21.4 mc IF signal is applied to the grid of the first preamplifier tube, V–201, through a series tuned circuit formed by inductor L–201, its distributed capacitance, and the input capacitance of V–201. R–201 is the grid loading resistor. The ac plate load is a double-tuned bandpass filter (T–201A, T–201B) that presents maximum signal voltage across the second preamplifier tube, V–202, at signal frequencies. Coupling capacitors, C–206 and C–207, provide frequency compensation and apply the amplified input signals from the plate of the first preamplifier to grid loading resistor R–207 of the second preamplifier. Resistor R–205, contained in transformer T–201A, functions both as a plate voltage dropping resistor and as an isolation resistor. This resistor decouples the plate circuit of first preamplifier stage from the two following preamplifier plate circuits through the common 150 vdc regulated supply line. Capacitors C–201 and C–202 complete the plate decoupling network with capacitor C–202 also decoupling the screen grid of V–201 in conjunction with screen grid resistor R–204. Resistor R–206 in conjunction with capacitors C–224 and C–215 form a low pass filter, blocking stray 21.4 mc signal frequencies from the 150 vdc regulated power supply. The cathode biasing network consists of resistors R–202 and R–203 (bypassed by capacitor C–203) in series with parallel resistances R–142 and GAIN control potentiometer R–109. Button type, feedthrough capacitor C–204, connects the cathode circuit of the first preamplifier

with the GAIN control located on main chassis. Undesirable RF Voltages capacitively coupled to tube filaments from cathodes are filtered from the ac filament supply by capacitors C–223 and C–225 in conjunction with chokes L–206 and L–207.

2.4.2 Subtype A, Second Stage. The amplified signals, broadly coupled from first preamplifier stage, are further amplified in the second preamplifier stage. The second preamplifier stage differs from the first in two respects: one, standard cathode bias is offered with no gain control; and two, an output, paralleling grid loading resistor R–211, is taken through coaxial cable W–201 to connector P–201. Two parallel, inductively tuned, broad-band filters, T–202A and T–202B, resonate at a center frequency of 21.4 mc and apply maximum signal voltage across the output line, and grid loading resistor R–211 of the third preamplifier, V–203. Frequency compensated capacitors C–213 and C–214 couple the output of the second stage to the input of the third stage.

2.4.3 Subtype A, Third Stage. The third preamplifier is utilized as a test amplifier only and is not in the operational signal path of the SDU. Its output is applied to auxiliary equipment used in testing and aligning the SDU. Frequency compensating components of the third preamplifier stage are grid resistor R–211 and plate decoupling capacitor C–219. The amplified 21.4 mc output from the plate circuit of V–203 is coupled across the bifilar windings of transformer T–203 without phase inversion. Rectification and detection occurs in the circuit composed of germanium diode CR–201, resistor R–216, and capacitor C–220. The series limiting resistor R–215 and button type feedthrough capacitor C–221 protect the germanium diode from external loading changes.

2.4.4 Subtype B, First Stage. Input to the preamplifier is taken from an SDU output jack on the telemetry receiver. The signals fed to the SDU output jack originate in either the first converter or first IF amplifier stage in the receiver. The 30-mc IF signal is applied to the grid of the first preamplifier tube, V–201, through a series tuned circuit formed by inductor L–201, its distributed capacitance, and the input capacitance of V–201. R–201 is the grid loading resistor. The ac plate load is a single-tuned bandpass filter (Z–202) that presents maximum signal voltage across the second preamplifier tube, V–202, at signal frequencies. Coupling capacitor, C–208, provides frequency compensation and applies the amplified input signals from the plate of the first preamplifier to grid loading resistor R–207 of the second preamplifier. Resistor R–206 functions both as a plate voltage dropping resistor and as an isolation resistor. This resistor decouples the plate circuit of first preamplifier stage from the two following preamplifier circuits through the common 150 vdc regulated supply line. Capacitors C–205 and C–206 decouple the plate and screen respectively. Resistor R–205 in conjunction with capacitors C–204 and C–217 form a low pass filter blocking stray 30 mc signal frequencies from the 150 vdc regulated power supply. The cathode biasing network consists of resistors R–202 and R–203 (bypassed by capacitor C–201) in series with parallel resistances R–142 and GAIN control potentiometer R–109. Button type, feedthrough capacitor C–202 connects the cathode circuit of the first preamplifier with the GAIN control located on main chassis. Undesirable RF voltages capactively coupled to tube filaments from cathodes are filtered from the ac filament supply by capacitors C–203 and C–210 in conjunction with chokes L–206 and L–207.

2.4.5 Subtype B, Second Stage. The amplified signals broadly coupled from first preamplifier stage are further amplified in the second preamplifier stage. The second preamplifier stage differs from the first in two respects: one, standard cathode bias is offered with no gain control; and two, an output, paralleling grid loading resistor R–211, is taken through coaxial cable W–201 to connector P–201. Two parallel, inductively tuned, broadband filters, T–201A and T–201B resonate at a center frequency of 30 mc and apply maximum signal voltage across the output line, and grid loading resistor R–211 of the third preamplifier, V–203. Frequency compensating capacitors C–213 and C–214 couple the output from the second stage to the input of the third stage.

2.4.6 Subtype B, Third Stage. The third preamplifier is utilized as a test amplifier only and is not in the operational signal path of the SDU. Its output is applied to auxiliary equipment used in testing and aligning the SDU. Frequency compensating components of the third preamplifier stage are grid resistor R–211 and plate decoupling capacitor C–220. The amplified 21.4 mc output from the plate circuit of V–203 is coupled across the bifilar windings (L–205A and L–205B) of transformer T–202 without phase inversion. Rectification and detection occurs in the circuit composed of germanium diode CR–201, resistor R–216, and capacitor C–222. The series limiting resistor R–215 and button type feedthrough capacitor C–223 protect the germanium diode from external loading changes.

2.4.7 Subtype C, First Stage. Input to the preamplifier is taken from an SDU output jack on the telemetry receiver. The signals fed to the SDU output jack originate in either the first converter or first

IF amplifier stage in the receiver. The 21.4 mc IF signal is applied to the grid of the first preamplifier tube, V–201, through a series tuned circuit formed by inductor L–201, its distributed capacitance, and the input capacitance of V–201. R–201 is the grid loading resistor. The ac plate load is a single-tuned bandpass filter (Z–202) that presents maximum signal voltage across the second preamplifier tube, V–202, at signal frequencies. Coupling capacitor, C–208, provides frequency compensation and applies the amplified input signals from the plate of the first preamplifier to grid loading resistor R–207 of the second preamplifier. Resistor R–206 functions both as a plate voltage dropping resistor and as an isolation resistor. This resistor decouples the plate circuit of first preamplifier stage from the two following preamplifier plate circuits through the common 150 vdc regulated supply line. Capacitors C–205 and C–206 complete the plate decoupling network with capacitor C–206 also decoupling the screen grid of V–201 in conjunction with screen grid resistor R–204. Resistor R–205, in conjunction with capacitors C–204 and C–217 form a low pass filter blocking stray 21.4 mc signal frequencies from the 150 vdc regulated power supply. The cathode biasing network consists of resistors R–202 and R–203 (bypassed by capacitor C–201) in series with parallel resistances R–142 and GAIN control potentiometer R–109. Button type, feedthrough capacitor C–204 connects the cathode circuit of the first preamplifier with the GAIN control located on the main chassis. Undesirable RF voltages capacitively coupled to tube filaments from cathodes are filtered from the ac filament supply by capacitors C–203 and C–210 in conjunction with chokes L–206 and L–207.

2.4.8 Subtype C, Second Stage. The amplified signals broadly coupled from first preamplifier stage are further amplified in the second preamplifier stage. The second preamplifier stage differs from the first in two respects: one, standard cathode bias is offered with no gain control; and two, an output, paralleling grid loading resistor R–211, is taken through coaxial cable W–201 to connector P–201. Two parallel, inductively tuned, broadband filters, T–201A and T–201B, resonate at a center frequency of 21.4 mc and apply maximum signal voltage across the output line, and grid loading resistor R–211 of the third preamplifier, V–203. Frequency compensation capacitors C–213 and C–214 couple the output from the second stage to the input of the third stage.

2.4.9 Subtype C, Third Stage. The third preamplifier is utilized as a test amplifier only and is not in the operational signal path of the SDU. Its output is applied to auxiliary equipment used in testing and aligning the SDU. Frequency compensation components of the third preamplifier stage are grid resistor R–211 and plate decoupling capacitor C–220. The amplified 21.4 mc output from the plate circuit of V–203 is coupled across the bifilar windings (L–205A and L–205B) of transformer T–202 without phase inversion. Rectification and detection occurs in the circuit composed of germanium diode CR–201, resistor R–216 and capacitor C–222. The series limiting resistor R–215 and button type feedthrough capacitor C–223 protect the germanium diode from external loading changes.

2.5 LOCAL OSCILLATOR, GENERAL.

The three stage local oscillator consists of a sweeping oscillator, a reactance modulator, and a horizontal sweep oscillator. The horizontal sweep oscillator and the reactance modulator frequency-modulate the sweeping oscillator at 30 cps through a maximum frequency deviation of ± 1.5 mc or a minimum frequency deviation of 0.0 mc about a center frequency of 25.7 mc, adjustable by the front panel control, SWEEP WIDTH. The cyclic frequency deviation is controlled by the reactance modulator acting as a variable reactance in the grid circuit of the sweeping oscillator. The reactance modulator is in turn controlled by the horizontal sweep oscillator which has a secondary function: the control of the CRT sweep repetition rate. The horizontal sweep oscillator synchronizes the modulation of the sweeping oscillator with the horizontal deflection of the CRT trace such that heterodyned, constant frequency signals always appear at the same place on the horizontal trace. The horizontal sweep oscillator also determines the CRT sweep width.

2.5.1 Sweeping Oscillator. Sweeping oscillator V–302 and associated circuitry operates in a modified Colpitts configuration. The tuned-grid circuit of the sweeping oscillator is complex and functionally consists of two tubes and associated circuitry: reactance modulator V–301 and horizontal sweep oscillator V–104. When these circuits are static the sweeping oscillator generates a single, resting frequency of 25.7 mc. When active, the sweeping oscillator successively generates all frequencies within a ± 1.5 mc maximum range of the center frequency. The plate circuit of reactance modulator tube V–301 parallels the sweeping oscillator grid circuit, and changes in reactance modulator plate current vary the capacitive reactance of the oscillator grid circuit. The variation in grid circuit reactance shifts the frequency of the sweeping oscillator a maximum of 1.5 mc above or 1.5 mc below center frequency depending upon the decrease or increase in capacitive reactance reflected from the

reactance modulator. The reactance is varied at a 30 cps rate and follows a sawtooth waveform that is generated by horizontal sweep oscillator V–104. The pulse width and slope of this sawtooth determine total reactive variation at the output of the reactance modulator. Manual CENTER FREQUENCY control, capacitor C–311, adjusts the center frequency (rest frequency) of the sweeping oscillator. The variable frequency output of the sweeping oscillator is capacitively coupled to mixer V–303 across the bus wires (C–318) between pins A and C of transformer T–301, and inductively across transformer windings L–304 and L–305. The output of tuned transformer T–301, broadened by shunting resistor R–308, is coupled to the grid of the mixer (V–303) through capacitor C–329 and developed across resistor R–314.

2.5.2 Reactance Modulator. The reactance modulator depicted in Figure 2–2 shifts the frequency of the sweeping local oscillator by shunting the oscillator grid circuit with a capacitor that effectively changes value. This capacitor, C–302, is in the RF plate circuit of the reactance modulator and forms a feedback loop to its grid. Feedback voltages are developed across resistor R–302 in the RF plate circuit between the grid and RF ground (across capacitor C–303). In a static state with no input from the horizontal sweep oscillator (V–104B) the only signal impressed across the modulator circuit is the oscillatory voltage from the grid circuit of the Colpitts local oscillator. Since the oscillator tank circuit is operating at resonance, both the oscillatory voltage E_1 and current I_1 are in phase. The oscillatory voltage appears across the modulator plate load, capacitor C–302 and resistor R–302. The reactance of capacitor C–302 at the resonant frequency of the oscillator is greater than the resistance of R–302, and therefore, the capacitive reactance determines the resultant current, causing it to lead voltage E_1 across capacitor C–302 by approximately 90 degrees. Current I_2 in resistor R–302 develops a voltage E_2 in phase with current I_2. The voltage E_2 across resistor R–302, however, leads the voltage E_1 across capacitor C–302 by approximately 90 degrees and is impressed between the grid of the reactance modulator and ground. Voltage E_2 at the grid of the reactance modulator causes a variation in plate current, I_3, which is directly coupled to the oscillator grid tank circuit. Plate current I_3 is approximately 90 degrees out of phase with the lagging oscillator current I_1 in the resonant grid tank circuit, and, since current I_1 is in phase with voltage E_1, the new current component leads the oscillatory voltage component by approximately 90 degrees. The two currents, I_1 and I_3 produce a new current vector that leads the tank circuit voltage vector and gives the effect of shunting the oscillator with a capacitor. The magnitude of current I_3 determines the apparent size of the shunting capacitor and, in turn, also determines the new resonant frequency of the oscillator. Hence, a changing current from the modulator plate circuit actively shifts the frequency of the sweeping oscillator. In order to modulate plate current, the bias on the reactance modulator is decreased exponentially and increased instantaneously at a 30 cps rate to an amplitude determined by the wiper setting of the SWEEP WIDTH potentiometer, R–112. Thus, as plate current is exponentially increased, the oscillator frequency sweeps down the frequency spectrum, and as the plate current instantaneously decreases, the oscillator frequency instantaneously flywheels to the high end of the spectrum and prepares to sweep down the spectrum at a rate determined by the exponential rise of bias voltage generated in the horizontal sweep oscillator, V–104, and tapped from potentiometer R–112.

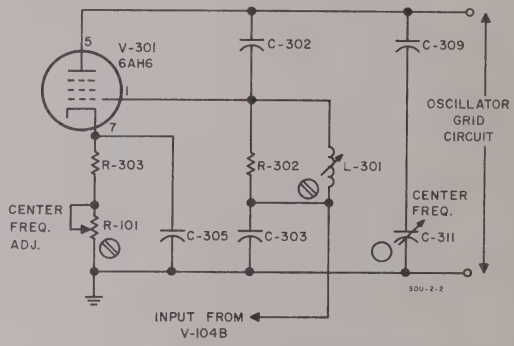


Figure 2–2. Reactance Modulator, SDU Types 200 and 300, Simplified Schematic Diagram

2.5.3 Horizontal Sweep Oscillator. The horizontal sweep oscillator (V–104A) is a single swing blocking oscillator. The network composed of resistor R–118 and capacitor C–108 in the grid circuit of the cathode follower (V–104B) and the plate circuit of the blocking oscillator is a sawtooth shaping circuit. Capacitor C–108 charges about a third RC time constant during the quiescent period of the blocking oscillator with the cathode follower duplicating the sawtooth waveform in the series-parallel resistive network composed of resistors R–115, R–113, potentiometers R–114 (SWEEP), R–116 (H GAIN) and R–112. After 1.5 cps of ac line voltage are impressed across the gird of the blocking oscillator through the primary of transformer T–102, capacitor C–106 in the blocking oscillator grid circuit has discharged the grid leak current of the previous blocking oscillator pulse through resistor R–110 and potentiometer R–111 and

decreases the bias up to cut-off. (V–104A previously being biased well below cut-off.) With the advent of the third positive ac voltage excursion on the grid of the blocking oscillator, the tube fires. The blocking oscillator plate current pulses through the secondary of transformer T–102 with an extremely short rise time, the plate current pulse being initiated by the positive-going waveform of every third positive ac excursion. Capacitor C–108, meanwhile charging to 150 vdc, is instantly discharged by the blocking oscillator late current pulse, thereby defining the sawtooth voltage waveform. During the plate current pulse, grid capacitor C–106 charges to a value below the tube cutoff point. Potentiometer R–111, a SYNC control in the grid leak network of the blocking oscillator, varies the point of tube firing on every third positive ac excursion and synchronizes the pulse repetition rate at 30 cps with the 60 cps ac line frequency. The output of the cathode follower is coupled to horizontal amplifier V–105 and reactance modulator V–301 via potentiometer R–116, capacitor C–109, and potentiometer R–114, capacitor C–107, and potentiometer R–112, respectively.

2.6 HORIZONTAL AMPLIFIER.

Horizontal amplifier V–105, is a dual triode with a common cathode configuration, a dual plate output, and a balanced grid network. In a static condition with no signal voltage applied to pin 2, identical voltages are developed across the two plate load resistors, R–119 and R–120. Since the horizontal deflection plates of the cathode ray tube parallel the triode plate circuits, identical plate voltages are impressed upon them, and the electron beam is equally repulsed from both deflection plates. In the absence of differential voltages applied to the vertical deflection plates, a dot is produced on the CRT screen. Application of differential voltages to the horizontal deflection plates repulses the electron beam by a greater amount from the deflection plate having the lesser impressed positive voltage. This differential voltage is a function of unequal voltages developed across the horizontal amplifier plate load resistors, which in turn, is a function of the unequal signal voltages applied to the two grids of the dual triode. A cyclic and varying voltage appearing across the plate load resistors causes repetitive, lateral movement of the electron beam and produces a horizontal trace on the CRT screen that is proportional in its deflection to the amplitude of the voltage. The cyclic and varying voltage appearing across the plate load resistors is the dc amplitude equivalent of the sawtooth waveform generated by the previous stage, and horizontal sweep oscillator. The sawtooth waveform is coupled across capacitor C–109 to the grid of V–105A where it breaks the equalization between the two triode sections by decreasing the bias established across the voltage divider network composed of potentiometer R–124 (H POS) and resistors R–125, R–126, and R–127, R–128. Grid resistors R–121 and R–123 in conjunction with resistances of the voltage divider network isolate V–105B grid from the sawtooth input. Capacitor C–110 shunts low frequency variations to ground. The decreasing bias applied to the grid of V–105A causes increased conduction with tube current limited by cathode resistor R–122. Therefore, with increased conduction in V–105A, V–105B decreases conduction proportionately, and as the amplitude of the sawtooth waveform applied to the grid of V–105A increases to its greatest amplitude, the conduction differential in the two triode sections is maximum. The plate resistors produce two outputs yielding sawtooth waveforms that are inverted with respect to each other. The two inverted waveforms are applied simultaneously to the horizontal deflection plates and provide the necessary electrostatic forces to sweep the CRT electron beam.

2.7 MIXER, GENERAL.

All amplified signals within the composite frequency spectrum of the telemeter-SDU combination are fed to the mixer and heterodyned with the output of the frequency-modulated local oscillator. A beat-frequency difference of 4.3 mc is produced for every signal appearing within the composite frequency spectrum regardless of its position relative to the input center frequency of the associated receiver, because the local oscillator sweeps the input spectrum a constant IF above any signal frequencies appearing therein. In the case where the input center frequency to the SDU is 30.0 mc rather than 21.4 mc, the FM local oscillator sweeps the input spectrum a constant IF below.

2.7.1 Mixer Input. The mixer stage, composed of pentagrid converter tube V–303, and associated circuitry, receives two inputs. One input is the sweeping local oscillator voltage coupled across capacitor C–329 and grid resistor R–314 and applied to pin I on V–303, the control grid of the mixer. A second input is the signal voltage(s) from the preamplifier developed across resistor R–316 and applied to pin 7 of V–303, the injector grid. Mixer tube current is modulated by the two input voltage. The signal on the control grid is constantly changing at a rate of 30 cps from 24.2 mc to 27.2 mc. The input signal on the injection grid is, by comparison, relatively constant. Oscillator modulation occurs between the cathode and the screen grid, and the signal modulation occurs between the screen grid and the plate. Interaction between the two input circuits is minimized by the decoupling action of the screen grid (pin 6 of V–303).

2.7.2 Mixer Output. The instantaneous output of the mixer, that is accepted by the tuned plate circuit within transformer assembly T–302A, is a beat frequency of 4.3 mc regardless of the spectral position of the signal voltage within the bandpass of the preamplifier. In the next instant of time the frequency of the local oscillator input voltage to the mixer changes and the same IF difference of 4.3 mc is generated, but against a new frequency of the signal spectrum that is removed from the previous signal voltage in frequency by an amount equal to the change in frequency of the local oscillator. For example, at an input spectral frequency of 21.4 mc the local oscillator sweeps all frequencies from 24.2 mc to 27.2 mc at a 30 cps rate to produce a single beat or difference frequency of 4.3 mc at a specific local oscillator frequency of 25.7 mc. That is, every 1/30 second a 4.3 mc IF is produced for the duration of the 21.4 mc input pulse at the center of the sweep period. The sweep period is approximately 33 milliseconds with the IF produced at the midpoint, or 16.5 milliseconds. Thus, an input center frequency signal (21.4 mc) appears 16.5 milliseconds after the sweep starts. With two new equal amplitude spectral signal frequencies of 21.6 mc and 21.7 mc presented to the mixer, three IF pulses are generated at different times along the sweeping local oscillator time axis, as in the following:

Local oscillator sweeps.....	24.2	to	27.2 mc
Three simultaneous inputs at..	21.1	21.4	21.7 mc
Three IF pulses generated....	4.3	4.3	4.3 mc
Time after sweep start.....	13.2	16.5	19.8 msec

The 4.3 mc mixer output is resonated in two broadly tuned parallel tank circuits contained within transformer assembly cans T–302A and T–302B. Both tuned circuits shunt the capacitive coupling path composed of series capacitors C–330 and C–331 between the plate of the mixer and the grid of the first IF amplifier.

2.8 IF AMPLIFIER, GENERAL.

The IF subchassis contains three IF stages consisting of V–401, V–402, and V–403 in addition to diode detector, V–404. Signal frequencies of 4.3 mc ±20 kc are accepted by the IF amplifier. Signals closer in frequency than 20 kc are presented on the CRT trace as a single, widened deflection and are not separable upon expanding the CRT trace with the SWEEP WIDTH control. Signals at a 20 kc frequency difference or greater are resolvable since they appear as double deflections with a valley between peaks which is down at least 6 db from peak signal level.

2.8.1 First and Second IF Amplifiers. Input to the first IF amplifier, V–401, is from the mixer output through connector J–401 on the IF subchassis. The interstage circuitry of the three IF amplifiers is nearly identical, the only difference being the GAIN control (R–109) in the cathode of the first two amplifiers. This potentiometer also controls the gain of the preamplifier first stage, V–201. The 4–3 mc IF is amplified in V–401 and coupled capacitively to the grid of the second IF amplifier through series connected capacitors C–407 and C–408. Signal voltages at the IF are developed across bandpass filter T–401A. Neutralizing capacitor C–405 cancels spurious voltage fluctuations by applying a portion of the plate voltage to the control grid through the screen-to-control grid interelectrode capacity. Bandpass filter T–401B, composed of tuned inductor L–402 and voltage dividing capacitors C–409 and C–410, develops maximum signal voltage at the IF and applies it across the input grid circuit of the second IF amplifier, V–402. Resistor R–406 in parallel with the grid bandpass filter depresses the circuit "Q" to broaden the response. The amplified 4.3 mc IF is further amplified in the second IF amplifier, V–402, and coupled capacitively to the grid of the third IF amplifier, V–403, through series connected capacitors C–147 and C–418.

2.8.2 Third IF Amplifier. The third IF amplifier, V–403, is the final stage of IF amplification prior to signal detection. Neutralizing capacitor C–425 is shunted by screen dropping resistor R–413 that connects the screen to the regulated 150 vdc supply through plate dropping resistor, R–414. Coupling of the IF to the detector is accomplished capacitively by series connected capacitors C–428 and C–429. Signal voltages at 4–3 mc are developed across the high impedance bandpass filters, T–403A and T–403B, and are impressed across the diode detector, V–404.

2.9 VIDEO DETECTOR AND VERTICAL AMPLIFIER, GENERAL.

The video detector is a single diode that detects voltage fluctuations representative of 4.3 mc signals at the output of the third IF amplifier. The circuitry linking the cathode of the detector and the vertical amplifier is designed for two purposes: one, to couple voltage variations from the detector to the vertical amplifier and two, to provide a biasing network to maintain the CRT trace at the proper vertical level. The vertical amplifier consists of a duo-triode that accepts the voltage changes from the detector, amplifies, and differentially applies them to the vertical deflection plates of the cathode ray tube.

2.9.1 Video Detector. Rectification and detection of the modulated IF input to the detector occurs in the dc circuit defined by tube current flow; namely, diode V–404, voltage divider network composed of resistors R–418, R–419, and IF filtering capacitor C–431. Resistors R–418, R–419, each develop a dc voltage proportional to the modulation voltage of the IF signal.

2.9.2 Vertical Amplifier. The control grids of the vertical amplifier (pins 2 and 7 of V–107) are essentially coupled across resistor R–418. Consequently, the voltage impressed across resistor R–418 is simultaneously applied to both inputs of the vertical amplifier. A fixed bias is maintained in the grid-cathode circuit of V–107A by the setting of potentiometer R–136 (V POS) and a constant tube current in this half of the duo-triode maintains a constant voltage differential across the vertical system, thereby positioning the quiescent horizontal CRT trace at the bottom of the CRT screen. Signal voltages are viewed as vertical deflections in the horizontal CRT trace, and, in order to deflect the horizontal trace, the bias on V–107A is increased as follows: The voltage changes across resistor R–149 are coupled through IF decoupling network composed of resistor R–416 and shunting capacitor C–433 to resistor R–137 in the voltage divider circuit of the vertical amplifier. An increase in voltage across resistor R–137 forces a redistribution of the individual voltages across the remaining two resistances of the voltage divider, resistor R–135 and potentiometer R–136, such that the voltage across each decreases. A decrease in the voltage across potentiometer R–136 increases the bias on V–107A, decreasing current flow and correspondingly increasing the voltage on the upper deflection plate of the CRT, pin 10 of V–106 in the plate circuit of V–107A. Concurrent with the increased bias of V–107A and the resultant voltage increase on the upper deflection plate of the CRT, the bias on V–107B is lowered by a positive voltage that appears at the grid. This voltage is directly coupled to the grid of V–107B from resistor R–418 through isolation resistor R–420. Current through V–107B increases, plate voltage drops, and the decreasing plate voltage is directly applied to the lower CRT deflection plate.

2.10 CATHODE RAY TUBE.

The cathode ray tube, V–106, a type 3RP1A, consists of an electron gun, two pairs of deflection plates, and a phosphor-coated screen, all enclosed in an evacuated glass envelope. When the elements of the electron gun and the deflection plates are operated at high potentials and in the proper ratios, a continuous stream of electrons is emitted from the gun, focused into a narrow beam, accelerated to a high velocity, and directed to impact upon the phosphorus material that coats the internal side of the screen. The high velocity electrons strike the phosphorus where energy is transferred and radiation occurs in the form of visible light. The light generated by the beam of high energy electrons striking the phosphorus is viewed by the observer as a pin-point light source. The electron beam is electrostatically deflected according to the vector sum of all voltages that instantaneously appear on any combination of the four deflection plates. Displacement of the beam and correspondent pin-point of light is a function of the differential voltages applied to the deflection system. The application of rapidly changing voltages to the deflection system produces a panoramic pattern on the face of the CRT that appears to be continuous due to the persistence (afterglow) of the phosphorus. Potentiometer R–130, labeled INT, controls the brightness of the CRT trace by varying the CRT bias voltage. Control grid voltage is maintained at —760 vdc (pin 2). Potentiometer R–133 labeled FOCUS is in the same voltage divider circuit as the INT control and applies approximately —500 vdc to pin 4 of the CRT for electrostatic focusing. The ASTIG control (R–129) applies a positive voltage to pin 8 of V–106 to control the circular symmetry of the pin-point light source. CRT trace positioning potentiometers R–124, H POS, and R–136, V POS, are in grid voltage-divider networks of the horizontal and vertical amplifiers, V–105B and V–107A, respectively. The H POS control positions the CRT trace along the horizontal or X axis. The V POS control positions the CRT trace along the vertical or Y axis.

2.11 POWER SUPPLY.

Power for the operation of the SDU is taken from any 115 vac 50–60 cycle supply through a 10-foot power cord to connector receptacle J–101 on the rear apron of the SDU. POWER switch, S–101, controls the primary circuit of transformer T–101 which is fused with a 1 ampere Slo-Blo fuse, F–101. The high voltage secondary of transformer T–101 applies 315 vac across the plates of a type 5Y3GT rectifier, V–101. The three additional secondary windings supply ac filament voltages to the rectifier, the cathode ray tube, and the remaining vacuum tubes. A 300 vdc output is taken from the filter network composed of capacitor C–101A, B, capacitor C–102A, and resistor R–102. The output of the rectifier at 340 vdc is paralleled by a pair of voltage regulator tubes, type 0A2, V–102 and V–103 which yield 150 vdc regulated each. An additional B-plus source of 180 vdc is provided at the output of the filter network

composed of resistor R–108 and capacitor C–101C. A negative supply is developed from the high voltage winding through a rectifier-voltage doubler circuit consisting of capacitor C–103 and diodes CR–101 and CR–102. Diode CR–101 conducts on each positive ac cycle coupled through capacitor C–103 from the secondary of transformer T-101 and charges capacitor C–103 to the peak ac voltage. Diode CR–102 conducts on each negative ac cycle coupled through negatively charged capacitor C–103 and discharges this capacitor into capacitor C–104, thereby charging capacitor C–104 to approximately double the peak ac value at the plate of the low voltage rectifier, V–101. The voltage doubling capacitor C–104 in conjunction with resistor R–103, and output capacitor C–105, filter the —760 vdc output.

Section III. Subtype D

2–12 PREAMPLIFIER, GENERAL.

A three stage, frequency compensated preamplifier accepts the receiver IF plus all signals within a maximum bandwidth of ±1.5 mc. After two stages of amplification, the spectral frequencies are fed to both a mixer stage and to a third stage of amplification. The rectified output of the third amplifier stage provides source signals to auxiliary test equipment.

2.12.1 Subtype D, First Stage. Input to the preamplifier is taken from an SDU output jack on the telemetry receiver. The signals fed to the SDU output jack originate in either the first converter or first IF amplifier stage in the receiver. The 21.4 mc IF signal is applied to the grid of the first preamplifier tube, V–201, through a series tuned circuit formed by inductor L–201, its distributed capacitance, and the input capacitance of V–201. R–201 is the grid loading resistor. The ac plate load is a double-tuned bandpass filter (T–201 and T–202) that presents maximum signal voltage across the second preamplifier tube, V–202, at signal frequencies. Coupling capacitors, C–208 and C–209, provide frequency compensation and apply the amplified input signals from the plate of the first preamplifier to grid loading resistor R–207 of the second preamplifier. Resistor R–205, contained within transformer T–201 functions both as a plate voltage dropping resistor and as an isolation resistor. This resistor decouples the plate circuit of the first preamplifier stage from the two following preamplifier plate circuits through the common 150 vdc regulated supply line. Capacitors C–205 and C–204 decouple the plate circuit and the screen grid circuit respectively. Resistor R–204 is the screen voltage dropping resistor. Resistor R–206 in conjunction with capacitors C–206 and C–215 form a low-pass filter, blocking stray 21.4 mc signal frequencies from the 150 vdc regulated power supply. The cathode biasing network consists of resistors R–202 and R–203 (the latter bypassed by capacitor C–202) in series with parallel resistances R–139 and GAIN control potentiometer R–140. Button type, feedthrough capacitor C–203 connects the cathode circuit of the first preamplifier with the GAIN control located on main chassis. Undesirable RF voltages capacitively coupled to tube filaments from cathodes are filtered from the ac filament supply by capacitors C–201 and C–214, in conjunction with chokes L–202 and L–203.

2.12.2 Subtype D, Second Stage. The amplified signals broadly coupled from the first preamplifier stage are further amplified in the second preamplifier stage. The second preamplifier stage differs from the first in two respects: one, standard cathode bias is offered with no gain control; and two, an output, paralleling grid loading resistor R–211, is taken through coaxial cable W–201 to connector P–201. Two parallel, inductively tuned, broadband filters, T–203 and T–204, resonate at a center frequency of 21.4 mc and apply maximum signal voltage across the output line and grid loading resistor R–211 of the third preamplifier, V–203. Frequency compensating capacitors, C–217 and C–218, couple the output of the second stage to the input of the third stage.

2.12.3 Subtype D, Third Stage. The third preamplifier is utilized as a test amplifier only and shunts the operational signal path in the SDU. Its output is applied to auxiliary equipment used in testing and aligning the SDU. Frequency compensation components of this stage are grid resistor R–211 and plate decoupling capacitor C–222. The amplified 21.4 mc output from the plate circuit of V–203 is coupled across the bifilar windings of transformer T–205 without phase inversion. Rectification and detection occurs in the circuit composed of germanium diode CR–201, resistor R–216, and capacitor C–223. The series limiting resistor R–217 and button type, feedthrough capacitor C–224 protect the germanium diode from abrupt changes in the external load.

2.13 LOCAL OSCILLATOR, GENERAL.

The three stage local oscillator consists of a sweeping oscillator, a reactance modulator, and a horizontal sweep oscillator. The horizontal sweep oscillator and the reactance modulator frequency-modulate the sweeping oscillator at 30 cps through a maximum frequency deviation of ±1.5 mc or a minimum frequency deviation of 0.0 mc about a center frequency of 25.7 mc, adjustable by the front panel control, SWEEP WIDTH. The cyclic frequency deviation is controlled by the reactance modulator acting as a variable

reactance in the grid circuit of the sweeping oscillator. The reactance modulator is in turn controlled by the horizontal sweep oscillator which has a secondary function: the control of the CRT sweep repetition rate. The horizontal sweep oscillator synchronizes the modulation of the sweeping oscillator with the horizontal deflection of the CRT trace such that heterodyned, constant frequency signals always appear at the same place on the horizontal trace. The horizontal sweep oscillator also determines the CRT sweep width.

2.13.1 Sweep Oscillator. Sweeping oscillator V–302 and associated circuitry operates in a modified Colpitts configuration. The tuned-grid circuit of the sweeping oscilator is complex and functionally consists of two tubes and associated circuitry: reactance modulator V–301, and horizontal sweep oscillator V–101. When these circuits are static the sweeping oscillator generates a single, resting frequency of 25.7 mc. When active, the sweeping oscillator successively generates all frequencies within a ±1.5 mc maximum range of center frequency. The plate circuit of reactance modulator tube V–301 parallels the sweeping oscillator grid circuit, and changes in reactance modulator plate current vary the capacitive reactance of the oscillator grid circuit. The variation in grid circuit reactance shifts the frequency of the sweeping oscillator a maximum of 1.5 mc above or 1.5 mc below center frequency depending upon the decrease or increase in capacitive reactance reflected from the reactance modulator. The reactance is varied at a 30 cps rate and follows a sawtooth waveform that is generated by horizontal sweep oscillator V–101. The pulse width and slope of this sawtooth determine total reactive variation at the output of the reactance modulator. Manual CENTER FREQUENCY control, capacitor C–310, adjusts the center frequency (rest frequency) of the sweeping oscillator. The variable frequency output of the sweeping oscillator is capacitively coupled to mixer V–303 across series connected coupling capacitors C–318, C–319 and inductively coupled across the windings of transformer assemblies T–302A and T–302B. The output of tuned transformer T–302B, broadened by shunting resistor R–308, is coupled to the grid of the mixer (V–303) through capacitor C–319 and developed across resistor R–310.

2.13.2 Reactance Modulator. The reactance modulator (V–301) depicted in Figure 2–3 shifts the frequency of the sweeping local oscillator by shunting the oscillator grid circuit with a capacitor that effectively changes value. This capacitor, C–302 is in the RF plate circuit of the reactance modulator and forms a feedback loop to its grid. Feedback voltages are

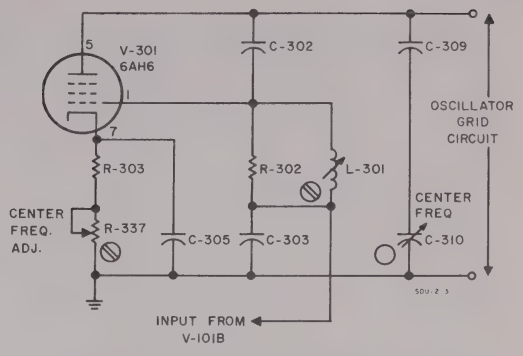


Figure 2–3. Reactance Modulator, SDU Type 350, Simplified Schematic Diagram

developed across resistor R–302 in the RF plate circuit between the grid and RF ground (across capacitor C–303). In a static state with no input from the horizontal sweep oscillator (V–101A) the only signal impressed across the modulator circuit is the oscillatory voltage from the grid circuit of the Colpitts local oscillator. Since the oscillator tank circuit is operating at resonance, both the oscillatory voltage E_1 and current I_1 are in phase. The oscillatory voltage appears across the modulator plate load, capacitor C–302 and resistor R–302. The reactance of capacitor C–302 at the resonant frequency of the oscillator is greater than the resistance of R–302, and therefore, the capacitive reactance determines the resultant current, causing it to lead voltage E_1 across capacitor C–302 by approximately 90 degrees. Current I_2 in resistor R–302 develops a voltage E_2 in phase with current I_2. The voltage E_2 across resistor R–302 however, leads the voltage E_1 across capacitor C–302 by approximately 90 degrees and is impressed between the grid of the reactance modulator and ground. Voltage E_2 at the grid of the reactance modulator causes a variation in plate current, I_3, which is directly coupled to the oscillator grid tank circuit. Plate current I_3, is approximately 90 degrees out of phase with the lagging oscillator current I_1 in the resonant grid tank circuit, and, since current I_1 is in phase with voltage E_1, the new current component leads the oscillatory voltage component by approximately 90 degrees. The two currents I_1 and I_3 produce a new current vector that leads the tank circuit voltage vector and gives the effect of shunting the oscillator with a capacitor. The magnitude of current I_3 determines the apparent size of the shunting capacitor, and, in turn, also determines the new resonant frequency of the oscillator. Hence, a changing current from the modulator plate circuit actively shifts the frequency of the sweeping oscillator. In order to modulate plate current, the bias on the

reactance modulator is decreased exponentially and increased instantaneously at a 30 cps rate to an amplitude determined by the wiper setting of the SWEEP WIDTH potentiometer, R–108. Thus, as plate current is exponentially increased, the oscillator frequency sweeps down the frequency spectrum, and as the plate current instantaneously decreases, the oscillator frequency instantaneously flywheels to the high end of the spectrum and prepares to sweep down the spectrum at a rate determined by the exponential rise of bias voltage generated in the horizontal sweep oscillator, V–101, and tapped from potentiometer R–108.

2.13.3 Horizontal Sweep Oscillator. The Horizontal Sweep Oscillator (V–101A) is a single swing blocking oscillator. The network composed of resistor R–113 and capacitor C–111 in the grid circuit of the cathode follower (V–101B) and the plate circuit of the blocking oscillator is a sawtooth shaping circuit. Capacitor C–111 charges about a third RC time constant during the quiescent period of the blocking oscillator with the cathode follower duplicating the sawtooth wave form in the series-parallel resistive network composed of resistors R–111, R–109, potentiometers R–110 (SWEEP) R–114 (H GAIN), and R–108, a manually controlled SWEEP WIDTH potentiometer. After 1.5 cps of ac line voltage are impressed across the grid of the blocking oscillator through the primary of transformer T–102, capacitor C–108 in the blocking oscillator grid circuit has discharged the grid leak current of the previous blocking oscillator pulse through resistor R–106 and potentiometer R–107 and decreases the bias up to cutoff, (V–101A previously being biased well below cutoff). With the advent of the third positive ac voltage excursion on the grid of the blocking oscillator, the tube fires. The blocking oscillator plate current pulses through the secondary of transformer T–102 with an extremely short rise time, the plate current pulse being initiated by the positive-going waveform of every third positive ac excursion. Capacitor C–111, meanwhile charging to 150 vdc, is instantly discharged by the blocking oscillator plate current pulse, thereby defining the sawtooth voltage waveform. During the plate current pulse, grid capacitor C–108 charges to a value below the tube cutoff point. Potentiometer R–107, a SYNC control in the grid leak network of the blocking oscillator, varies the point of tube firing on every third positive ac excursion and synchronizes the pulse repetition rate at 30 cps with the 60 cps line frequency. The output of the cathode follower is coupled to horizontal amplifier V–102 and reactance modulator V–301 via potentiometer R–114, capacitor C–110, and potentiometer R–110, capacitor C–109, and potentiometer R–108, respectively.

2.14 HORIZONTAL AMPLIFIER.

Horizontal amplifier V–102 is a dual triode with a common cathode configuration, a dual plate output, and a balanced grid network. In a static condition with no signal voltage applied to pin 3 of V–102, identical voltages are developed across plate load resistors R–115 and R–116. Since the horizontal deflection plates of the cathode ray tube parallel the triode plate circuits, identical plate voltages are impressed upon them, and the electron beam is equally repulsed from both deflection plates. In the absence of differential voltages applied to the vertical deflection plates a dot is produced on the CRT screen. Application of differential voltages to the horizontal deflection plates repulses the electron beam by a greater amount from the deflection plates having the lesser impressed positive voltage. This differential voltage is a function of unequal voltages developed across the horizontal amplifier plate load resistors, which in turn, is a function of the unequal signal voltages applied to the two grids of the dual triode. A cyclic and varying voltage appearing across the plate load resistors causes repetitive, lateral movement of the electron beam and produces a horizontal trace on the CRT screen that is proportional in its deflection to the amplitude of the voltage. The cyclic and varying voltage appearing across the plate load resistors is the dc amplitude equivalent of the sawtooth waveform generated by the previous stage, the horizontal sweep oscillator. The sawtooth waveform is coupled across capacitor C–110 to the grid of V–102A where it breaks the equalization between the two triode sections by decreasing the bias established across the voltage divider network composed of potentiometer R–119, (H POS), resistors R–124, R–123, R–122 and R–121. Grid resistors R–120 and R–118 in conjunction with resistances of the voltage divider network isolate V–102B grid from the sawtooth input. Capacitor C–112 shunts low frequency variations to ground. The decreasing bias applied to the grid of V–102A causes increased conduction with tube current limited by cathode resistor, R–117. Therefore, with increased conduction in V–101A, V–101B decreases conduction proportionately, and, as the amplitude of the sawtooth waveform applied to the grid of V–102A increases to its greatest amplitude, the conduction differential in the two triodes is maximum. The plate resistors produce two outputs yielding sawtooth waveforms that are inverted with respect to each other. The two inverted waveforms are applied simultaneously to the horizontal deflection plates and provide the necessary electrostatic forces to sweep the CRT electron stream.

2.15 MIXER, GENERAL.

All amplified signals within the composite frequency spectrum of the telemeter-SDU combination are fed to the mixer and are heterodyned with the output of the frequency-modulated local oscillator. A beat-frequency difference of 4.3 mc is produced for every signal appearing within the composite frequency spectrum regardless of its position relative to the input center frequency of the associated receiver, because the local oscillator sweeps the input spectrum a constant IF above any signal frequencies appearing therein.

2.15.1 Mixer Input. The mixer stage, composed of pentagrid converter tube V–303 and associated circuitry, receives two inputs. One input is the sweeping local oscillator voltage coupled across the network composed of coupling capacitor C–319 and grid resistor R–310 and applied to pin 1 on V–303, the control grid of the mixer. A second input is the signal voltage(s) from the preamplifier developed across resistor R–311 and applied to pin 7 of V–303; the injector grid mixer tube current is modulated by the two input voltages. The signal on the control grid is constantly changing at a rate of 30 cps from 24.2 mc to 27.2 mc. The input signal on the injection grid is, by comparison, relatively constant. Oscillator modulation occurs between the cathode and the screen grid, and the signal modulation occurs between the screen grid and the plate. Interaction between the two input circuits is minimized by the decoupling action of the screen grid (pin 6 of V–303).

2.15.2 Mixer Output. The instantaneous output of the mixer, that is accepted by the tuned plate circuit within transformer T–303, is a beat frequency of 4.3 mc regardless of the spectral position of the signal voltage within the bandpass of the preamplifier. In the next instant of time the frequency of the local oscillator input voltage to the mixer changes and the same IF difference of 4.3 mc is generated, but against a new frequency of the signal spectrum that is removed from the previous signal voltage in frequency by an amount equal to the change in frequency of the local oscillator. For example, at an input spectral frequency of 21.4 mc the local oscillator sweeps all frequencies from 24.2 mc to 27.2 mc at a 30 cps rate to produce a single beat or difference frequency of 4.3 mc at a specific local oscillator frequency of 25.7 mc. That is, every 1/30 second a 4.3 mc IF is produced for the duration of the 21.4 mc input pulse at the center of the sweep period. The sweep period is approximately 33 milliseconds with the IF produced at the mid-point, or 16.5 milliseconds after the sweep starts. Thus, an input center frequency signal (21.4 mc) appears 16.5 milliseconds after the sweep starts. With two new equal amplitude spectral signal frequencies of 21.4 mc and 21.7 mc presented to the mixer, three IF pulses are generated at different times along the sweeping local oscillator time axis, as in the following:

Local oscillator sweeps 24.2 to 27.2 mc			
Three simultaneous inputs at	21.1	21.4	21.7 mc
Three IF pulses generated	4.3	4.3	4.3 mc
Time after sweep start.	13.2	16.5	19.8msec

The 4.3 mc mixer output is resonated in two broadly tuned parallel tank circuits contained within transformer assembly cans T–303 and T–304. Both tuned circuits shunt the capacitive coupling path composed of series capacitors C–326 and C–327 between the plate of the mixer and the grid of the first IF amplifier, pin 1 of V–304.

2.16 IF AMPLIFIER, GENERAL.

The IF amplifier consists of three stages of amplification, V–304, V–305, and V–306. Signal frequencies of 4.3 mc ±20 kc are accepted by the IF amplifier. Signals closer in frequency than 20 kc are presented on the CRT trace as a single, widened deflection and are not separable upon expanding the CRT trace with the SWEEP WIDTH control. Signals at a 20 kc frequency difference or greater are resolvable since they appear as double deflections with a valley between peaks which is down at last 6 db from peak signal level.

2.16.1 First and second IF Amplifiers. Input to the first IF amplifier, V–304, is from the mixer output through series connected coupling capacitors C–326 and C–327 and across grid loading resistor R–316. The interstage circuitry of the three IF amplifiers is nearly identical, the only difference being the GAIN control (R–140) in the cathode of the first two amplifiers. This potentiometer also controls the gain of the preamplifier first stage, V–201. The 4.3 mc IF is amplified in V–304 and coupled capacitively to the grid of the second IF amplifier through series connected capacitors C–335 and C–336. Signal voltages at the IF are developed across bandpass filters T–305 and T–306. Neutralizing capacitor C–333 cancels spurious voltage fluctuations by applying a portion of the plate voltage to the control grid through the screen-to-control grid interrelectrode capacity. Bandpass filter T–306 develops maximum signal voltage at the IF and applies it across the input grid circuit of the second IF amplifier, V–305. Resistor R–321 in parallel with the grid bandpass filter depresses

the circuit "Q" to broaden the response. The amplified 4.3 mc IF is further amplified in the second IF amplifier, V–305, and coupled capacitively to the grid of the third IF amplifier, V–306, through series connected capacitors C–347 and C–348.

2.16.2 Third IF Amplifier. The third IF amplifier,V–306, is the final stage of IF amplification prior to signal detection. Neutralizing capacitor C–355 is shunted by screen dropping resistor R–329 that connects the screen to the regulated 150 vdc supply through plate dropping resistor R–331. Coupling of the IF to the detector is accomplished capacitively by series connected capacitors C–360 and C–361. Signal voltages at 4.3 mc are developed across the high impedance of the bandpass filters, T–309 and T–310, and are impressed across diode detector, CR–301.

2.17 VIDEO DETECTOR AND VERTICAL AMPLIFIER, GENERAL.

The video detector is a single diode that detects voltage fluctuations representative of 4.3 mc signals at the output of the third IF amplifier and resistively couples these fluctuations to the vertical amplifier. The circuitry linking the cathode of the detector and the vertical amplifier is designed for two purposes: one, to couple the voltage variations from the detectors to the vertical amplifier and two, to provide a biasing network to maintain the CRT trace at the proper vertical level. The vertical amplifier consists of a duo-triode that accepts the voltage changes from the detector, amplifies, and differentially applies them to the vertical deflection plates of the cathode ray tube.

2.17.1 Video Detector. Rectification and detection of the modulated IF input to the detector occurs in the dc circuit defined by tube current flow; namely, diode CR–301, voltage divider network composed of resistors R–334, R–333, and IF filtering capacitor C–364. Resistors R–334, R–333 each develop a dc voltage proportional to the modulation voltage of the IF signal.

2.17.2 Vertical Amplifier. The control grids of the vertical amplifier (pins 2 and 7 of V–103) are essentially coupled across resistor R–334. Consequently, the voltage impressed across resistor R–334 is simultaneously applied to both inputs of the vertical amplifier. A fixed bias is maintained in the grid-cathode circuit of V–103A by the setting of potentiometer R–132 (V POS) and a constant tube current in this half of the duo-triode maintains a constant voltage differential across the vertical system, thereby positioning the quiescent horizontal CRT trace at the bottom of the CRT screen. Signal voltages are viewed as vertical deflections in the horizontal CRT trace, and in order to deflect the horizontal trace, the bias on V–103A is increased as follows: The voltage changes across resistor R–333 are coupled through IF decoupling network composed of resistor R–332 and shunting capacitor C–363 to resistor R–131 in the voltage divider circuit of the vertical amplifier. An increase in voltage across resistor R–131 forces a redistribution of the individual voltages across the remaining two resistances of the voltage divider, resistor R–133 and potentiometer R–132, such that the voltage across each decreases. A decrease in the voltage across potentiometer R–132 increases the bias on V–103A, decreasing current flow and correspondingly inrceasing the voltage on the upper deflection plate of the CRT, (pin 7 of V–104) in the plate circuit of V–103A. Concurrent with the increased bias of V–103A and the resultant voltage increase on the upper deflection plate of the CRT, bias on V–107B is lowered by a positive voltage that appears at the grid. This voltage is directly coupled to the grid of V–103B from resistor R–334 through isolation resistor R–336. Current through V–103B increases, plate voltage drops, and the decreasing plate voltage is directly applied to the lower CRT deflection plate.

2.18 CATHODE RAY TUBE.

The cathode ray tube, V–106, a type 3XP1, consists of an electron gun, two pairs of deflection plates, and a phosphor-coated screen, all enclosed in an evacuated glass envelope. When the elements of the electron gun and the deflection plates are operated at high potentials and in the proper ratios, a continuous stream of electrons is emitted from the gun, focused into a narrow beam, accelerated to a high velocity, and directed to impact upon the phosphorous material that coats the internal side of the screen. The high velocity electrons strike the phosphorous where energy is transferred and radiation occurs in the form of visible light. The light generated by the beam of high energy electrons striking the phosphorous is viewed by the observer as a pin-point light source. The electron beam is electrostatically deflected according to the vector sum of all voltages that instantaneously appear on any combination of the four deflection plates. Displacement of the beam and correspondent pin-point of light is a function of the differential voltages applied to the deflection system. The application of rapidly changing voltages to the deflection system produces a panoramic pattern on the face of the CRT that appears to be continous due to the persistence (afterglow) of the phosphorous. Potentiometer R–127, labeled INT, controls the brightness of the CRT trace by varying the CRT bias voltage.

Cathode voltage is maintained at –910 vdc (pin 3). Potentiometer R–129 labeled FOCUS is in the same voltage-divider circuit as the INT control and applies approximately –640 vdc to pin 5 of the CRT for electrostatic focusing. The ASTIG control (R–125) applies a positive voltage to the center pin of V–104 to control the circular symmetry of the pin-point light source. CRT trace positioning potentiometers R–119, H POS and R–132 V POS, are in grid voltage-divider networks of the horizontal and vertical amplifiers, V–102 and V–103, respectively. The H POS control positions the CRT trace along the horizontal or X axis. The V POS control positions the CRT trace along the vertical or Y axis.

2.19 POWER SUPPLY.

Power for operation of the SDU is taken from either a 115 vac or 230 vac, 50-60 cps source through a 10-foot power cord, to connector receptacle J–102 on the rear apron of the SDU. POWER switch S–101 controls the primary circuit of transformer T–101 through power selector switch S–102 and through 1 ampere Slo-Blo fuse F–101, or, depending upon the position of the power selector switch, through 1/2 ampere Slo-Blo fuse F–102. The 5–6 secondary winding of transformer T–101, applies 197 vac (rms) across a bridge rectifier composed of silicon diodes CR–101 through CR–104 that feeds a filter network composed of inductor L–103 and capacitors C–103 and C–104. An output of 230 vdc unregulated is taken from the junction resistor R–102 and capacitor C–104. A regulated output of 150 vdc is taken across silicon diffused Zener diode CR–105 operating as a voltage regulator. The 7–8 secondary winding of transformer T–101 applies 6.3 vac across POWER ON light DS–101 and the filaments of all vacuum tubes in the SDU. The 9–10 secondary winding of transformer T–101 applies 1150 vac (rms) to a half wave rectifier system of six series connected silicon diodes, CR–106 through CR–111, from which a filtered output of –1200 vdc is applied to the CRT voltage divider network consisting of resistors R–126, R–128, R–130, and potentiometers R–127 and R–129. Equalizing resistors R–141 through R–146 nullify differences in individual diode peak-inverse voltages by bridging the diodes with an interconnected high resistance network. The —1200 vdc filtered output is taken at the junction of bleeder resistor R–105 and the filter network composed of capacitors C–105, C–106, C–107 and resistors R–103 and R–104. The 11–12 secondary winding of transformer T–101 applies 6.3 vac to the filaments of the CRT. Pin 3 of V–104 is common to both the filament and cathode circuit and is held at —910 vdc.

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Chapter 3
Operation

3.1 INSTALLATION.

The SDU is designed for mounting in standard 19-inch relay racks such as Model 1401–R Telemetry Receiver Rack, or Type DCR–1000 Equipment Rack, or AFMTC Model TLM–27–C Airborne Telemetry Rack, or it may be operated unmounted on any flat supporting surface such as a table or shelf. If the SDU is to be operated external of the equipment racks, the chassis components should be protected by the supplied dust covers and care should be taken to select a well ventilated operating location.

(1) On SDU types 350, place power selector switch on rear apron to proper position, either 115 vac or 230 vac depending upon power source.

(2) Connect power cord between SDU connector receptacle on the rear apron of the unit and a 50–60 cps ground polarized 115 vac or 230 vac power outlet.

(3) Connect the SDU output of telemetry receiver directly to SDU input, J–201, on rear apron of unit.

3.2 OPERATION.

(1) Apply power to SDU and associated receiver(s).

(2) Wait for base line to appear on CRT screen.

(3) Turn GAIN control up about half way.

(4) Turn SWEEP WIDTH control fully CW.

(5) Tune receiver slowly until one or more signals move across the CRT screen.

(6) Tune receiver very accurately to a known and active signal frequency and acknowledge signal presentation on CRT screen. The signal should appear exactly in the center of the CRT grid scale directly over the center frequency mark (—0+ on type 200 and 300 SDU and —MC+ on type 350 SDU).

(7) Position CENTER FREQUENCY control knob at midpoint of rotational limits.

(8) If the active signal is not centered on the CRT screen, rotate the CENTER FREQUENCY knob to center the active signal.

(9) Gradually turn SWEEP WIDTH control CCW and maintain the active signal at the center of the CRT screen with appropriate rotation of the CENTER FREQUENCY control until the expanded base of the signal occupies the entire screen width.

(10) Turn SWEEP WIDTH fully CW. The signal should remain centered on the CRT screen; if not, then proceed to the next step.

(11) Open CRT-image control panel door.

(12) Unlock HORIZONTAL POSITION (screwdriver) control and adjust until the signal is centered on CRT screen.

3.3 SIGNAL INTERPRETATION.

With little experience, the operator should be able to recognize visually the character of various signals without need of listening. However, the receiver must be adjusted properly if good results are to be obtained. The following guide may be used for signal interpretation.

(1) A constant carrier appears as a deflection of fixed height.

(2) An amplitude modulated carrier appears as a deflection of variable height. Voice or music modulation causes the carrier to vary irregularly resembling a bell-shaped, high-Q response curve. Continuous wave modulation of low frequency produces a series of convolutions varying in height, the number being determined by the modulation frequency. As the modulation frequency increases, the convolutions move toward the two sides of the deflection as the sidebands tend to become visible. When the modulation frequency is increased, it becomes possible to separate the two sidebands by reducing the sweep width. The higher the modulation frequency, the further away these sidebands move from the center deflection representing the carrier. Note that two opposed side-bands may appear unequal in height, due to the imperfect equalization of the receiver. Their relative heights may vary as the receiver is tuned and as the deflection moves from one end of the screen to the other.

(3) Single sideband two-tone modulation appears as two carriers of slightly different frequency. (See (8) below on signal interference.)

(4) A frequency-modulated carrier deviated at an extremely low rate appears as a carrier which is "wobbling" side-ways, whereas a frequency-modulated carrier deviated at a high rate,

high frequency modulation, appears as a carrier with a series of sidebands, their amplitudes being a function of the modulation index and their spacing a function of the modulating frequency.

(5) An FM signal modulated with speech or music appears as a multiplicy of deflections spreading over a variable bandwidth.

(6) A CW signal appears and disappears in step with the keying of the transmitter. During the moments when the signal is off, the frequency sweep axis closes at the base of the signal. A radio operator accustomed to reading CW signals, can, with little practice read such signals directly on the screen. In very rapidly keyed signals, the deflection and the base line are seen simultaneously.

(7) An MCW signal appears like a CW signal of periodically varying height. If the modulation rate is high, sidebands will appear as explained above in (2).

(8) Two signals which are so close in frequency as to cause aural interference (beats) may appear on the screen as a single deflection varying in height like a modulated signal. As the frequency separation is increased, the deflection appears as if modulated on one side only. Further increase of frequency causes a "break" in the apex of the deflection. By reducing the sweep width of the SDU, the respective deflections separate gradually.

(9) Transient disturbances, generally received as noises in the receiver, are of two types; periodic and random. Periodic transients, such as those produced by automobile ignition systems, motors, vibrators, and buzzers, appear as signals moving along the frequency sweep base line in one direction or another. Random transients, such as static, appear as irregular deflections and flashes along the whole frequency sweep axis.

(10) Tube noise appears as varying irregularities or grass along the base line, and is reduced by decreasing the gain control of the SDU and/or the RF gain of the associated receiver (if applicable).

(11) Image frequencies, if passed by the receiver and presented on the CRT screen, can be distinguished from normal signals because they move in the opposite direction with respect to normal signals when the receiver is tuned.

(12) Identification of harmonics in the CRT presentation is possible during active tuning of the companion receiver if the harmonics are produced by the heterodyning of strong input signals with harmonics of the oscillator frequency. During tuning, the harmonics move across the CRT screen at a higher rate than fundamental signal frequencies (twice as fast for the second harmonic).

(13) Diathermy apparatus using an unfiltered power supply produces periodic deflections on certain portions of the CRT trace because such equipment emits a pulsating signal synchronous with that of the power line. When a certain phase relationship exists, the SDU displays periodic diathermy pulses.

(14) If the signal strength exceeds a certain value, the deflection caused by any signal breaks up into a series of parallel deflections somewhat similar to sidebands. This distortion is eliminated by reducing the SDU gain.

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Chapter 4
Maintenance

4.1 GENERAL.

Spectrum Display Units are designed to give maximum trouble-free performance with a minimum of routine maintenance. High quality components are used throughout with typical operation held well within ratings. However, should trouble develop, maintenance personnel should thoroughly familiarize themselves with Chapter 2, Theory of Operation, and the preamplifier and main chassis schematic diagrams (Fig. 5–1 through 5–3). In addition, reference should be made to Figures 4–1 through 4–15 which show the location of all SDU parts. Tables 4–1 and 4–2 list tube socket voltages.

4.2 TROUBLE SHOOTING.

When the SDU does not operate properly, a complete visual inspection should be made. Check all power and signal input sources, cables, and connectors.

Table 4–1. *Tube Socket Voltage Chart, SDU Types 200 and 300*

Note: 115V AC INPUT. All measurements taken with RCA WV97A VTVM to chassis ground. GAIN control set to maximum; no input. SWEEP WIDTH set at maximum.

Tube	Type	Pin Number								
		1	2	3	4	5	6	7	8	9
V–101	5Y3GT		340		315 ac		315 ac		340	
V–102	OA2	150				150		0		
V–103	OA2	150				150		0		
V–104	12AU7	150	44	49	6.0 ac	6.0 ac	44	−21	0	0
V–105	12AT7	165	45	50	6.0 ac	6.0 ac	160	46	50	0
V–106	3RP1A	(see below)								
V–107	12AT7	200	49	53	6.0 ac	6.0 ac	150	50	53	0
				21.4 mc Preamplifier Subtypes A,C						
V–201	6BA6	0	Gnd	6.0 ac	Gnd	130	76	1.3		
V–202	6AU6	0	Gnd	6.0 ac	Gnd	133	90	1.4		
V–203	6AU6	0	Gnd	6.0 ac	Gnd	135	97	1.5		
				30.0 mc Preamplifier, Subtype B						
V–201	6BA6	0	0	6.1 ac	0	140	86	1.35		
V–202	6AU6	0	0	6.1 ac	0	144	102	1.4		
V–203	6AU6	0	0	6.1 ac	0	145	100	1.53		
				Oscillator-Mixer Subchassis						
V–301	6AH6	0	0	6.0 ac	0	190	148	2		
V–302	6AU6	−3.5	0	6.0 ac	0	195	146	0		
V–303	6BE6	−9.1	1.1	6.0 ac	0	140	104	0		
				IF Amplifier, Detector Subchassis						
V–401	6BA6	0	0	6.0 ac	0	190	80	1.3		
V–402	6BA6	0	0	6.0 ac	0	190	82	1.2		
V–403	6AU6	0	0	6.0 ac	0	140	99	1.5		
V–404	6AL5	50	0	4.65 ac	0	0	0	50		
V–106	3RP1A			Remove cover from socket to measure						
Pin No.	1	2	3	4	6	7	8	9	10	12
Voltage	*	−760	−730	−500	160	165	172	200	150	*

*Voltage between pins 1 and 12 is 6.1 vac (pins 5 and 11 not used).

Table 4–2. *Tube Socket Voltage Chart, SDU Type 350.*

Note: V–104 voltages taken by RCA Senior Voltohmyst WV 98A. All other voltages taken by Hewlett-Packard VTVM HP 410B GAIN fully CW, CENTER FREQUENCY centered, SWEEP WIDTH fully CW, INTENSITY fully CW, FOCUS fully CW, and no signal input.

Symbol	Type	1	2	3	4	5	6	7	8	9	Cap
V–101	5670	6.3ac	49	47	150	—	50	24	0	0	
V–102	5670	6.3ac	33	27	150	—	130	30	33	0	
V–103	5670	6.3ac	42	38	150	—	140	39	42	0	
V–104	3XP1	150	130	−910	−910	−640	150	140	−908	−910	115
V–201	6BA6	0	0	6.3ac	0	150	110	0.9	—	—	
V–202	6AU6	0	0	6.3ac	0	150	95	1.6	—	—	
V–203	6AU6	0	0	6.3ac	0	150	100	1.6	—	—	
V–301	6AH6	−1	0	6.3ac	0	220	150	1.3	—	—	
V–302	6AU6	−4	0	6.3ac	0	220	150	0	—	—	
V–303	6BE6	−3.8	1.3	6.3ac	0	140	100	0	—	—	
V–304	6BA6	0	0	6.3ac	0	220	85	1.2	—	—	
V–305	6BA6	0	0	6.3ac	0	220	90	1.3	—	—	
V–306	6AU6	0	0	6.3ac	0	145	105	1.5	—	—	

This includes all power fuses which are best checked for continuity by replacement with fuses known to be good. If the replacement fuse burns out under full load, search the power supply and its distribution lines for grounds or low resistance shorts. Any individual tube properly seated in its socket that fails to exhibit the glow of an energized filament must be replaced by its equivalent. If a series of tubes that is limited to a subchassis fails to display glowing filaments, then the subchassis connectors should be checked for broken filament lines.

4.2.1 Inoperative SDU. The lack of a CRT trace may be caused by misadjusted controls, lack of necessary operating voltages, or a defective CRT. Rotation of the INTENSITY control may or may not produce a trace on the CRT screen depending upon the positioning of the other CRT controls located on the same sub-panel. The controls marked V POS and H POS may be adjusted to determine if the trace has been moved completely off the CRT face. CRT operating voltages should first be checked at their source, the power supply. The rectifier tube, V–101 in the 200 and 300 SDU types can be checked by substitution; however, the rectifiers in the SDU type 350 are silicon diodes, and replacement for checking only is not recommended. Instead, voltage checks should be made if the power supply is suspect. If the power supply is found to be functioning normally and a spot or trace fails to appear on the CRT screen, operating voltages of the CRT should be checked with reference to Tables 4–1 and 4–2.

4.2.2 Power Selector Switch. The power selector switch S–102 located on the rear apron of the main chassis on SDU types 350 must be positioned correctly with respect to the source voltage applied. Otherwise, the SDU will remain inoperative after main power switch S–101 is thrown. Application of 230 vac to the SDU 350 when power selector switch S–102 is in the 115 vac position may seriously damage the SDU.

4.2.3 Improperly Operating SDU. Since defective vacuum tubes are the most prevalent cause of malfunctioning equipment, systematic tube substitution often eliminates this source of trouble. A horizontal trace with no vertical signals other than "grass" displayed at the maximum clockwise rotation of the GAIN control indicates that the input signal path to the CRT is broken. In SDU types 200 and 300 tube failure involving any of the following V–106, V–107, V–201, V–202, V–303, V–401, V–402, V–403, V–404, and in SDU types 350, V–304, V–305, V–306, silicon diode CR–301, V–103 and V–104, will prevent signals from appearing on the CRT screen. Systematic replacement of these tubes may determine the source of trouble. A vertical line on the CRT screen at maximum gain indicates that the horizontal sweep circuits are inoperative. Tubes V–104 and V–105 in SDU types 200 and 300, and tubes V–101 and V–102 in SDU type 350 should be replaced to determine if they are the source of trouble. A horizontal trace which shifts vertical position when a signal is received would indicate that V–107 in SDU type 200 and 300, or V–103 in SDU type 350, or its associated circuitry is

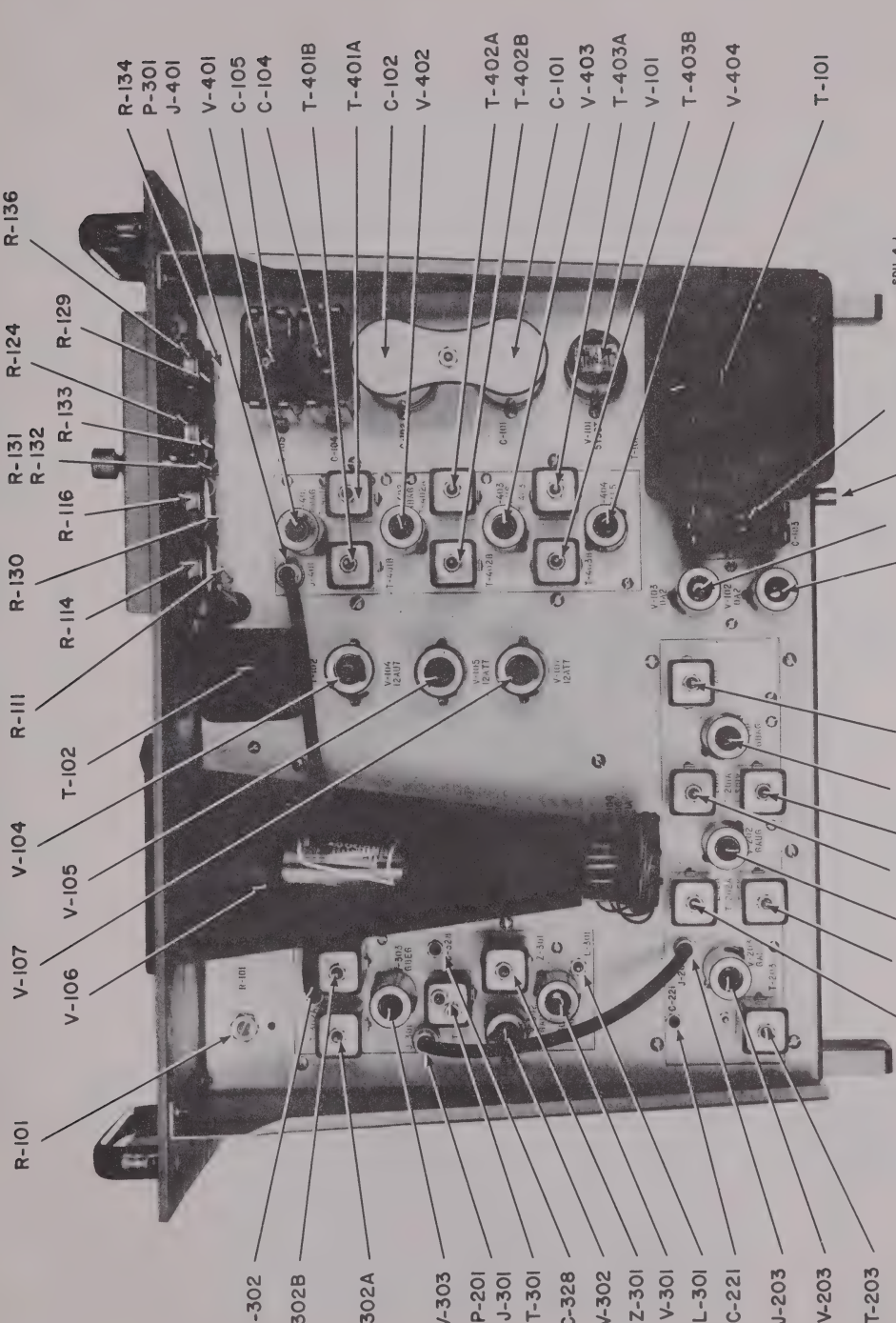


Figure 4-1. Top View, SDU Types 200 and 300, Component Identification

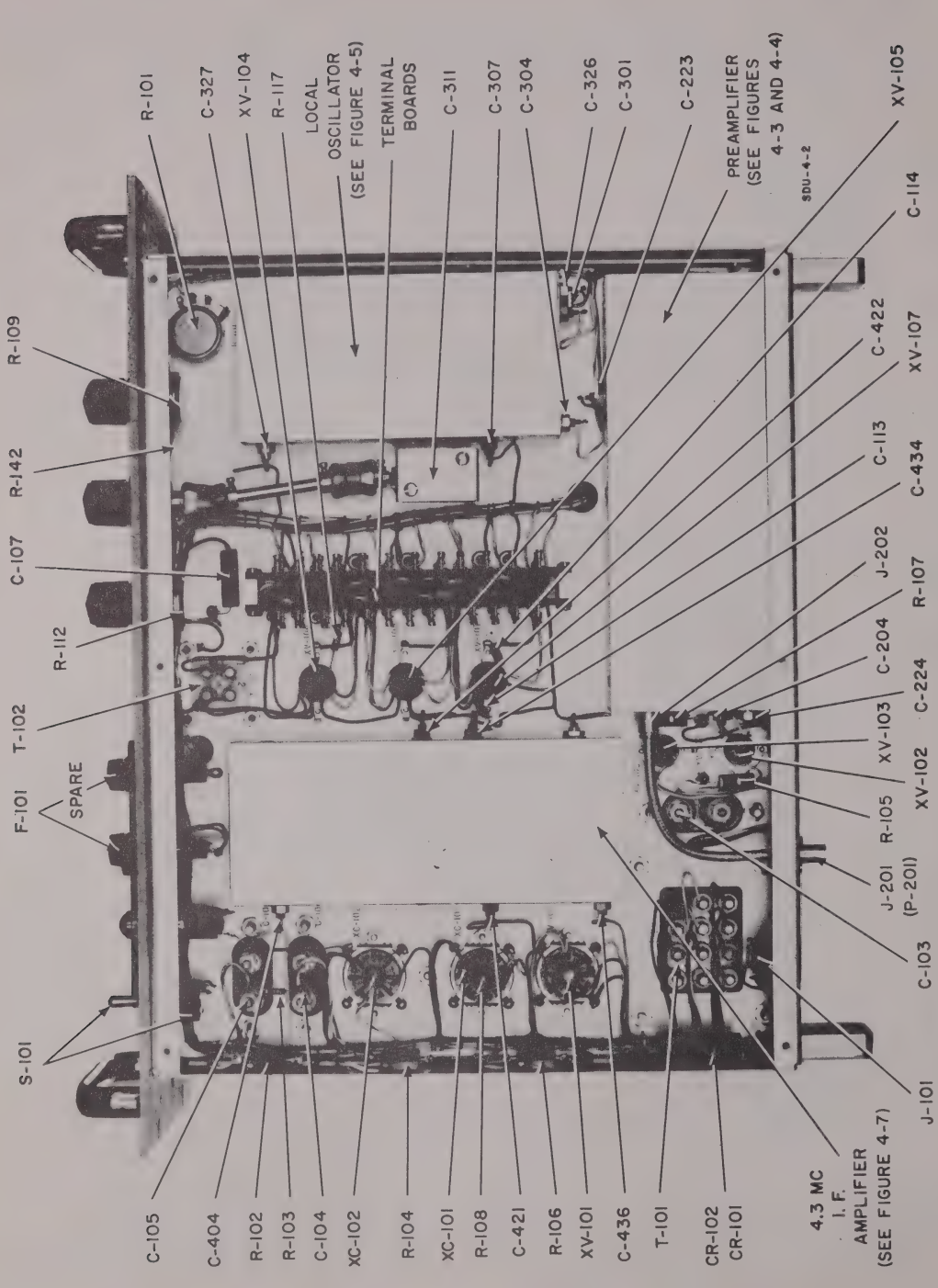


Figure 4–2. Bottom View, SDU Types 200 and 300, Component Identification

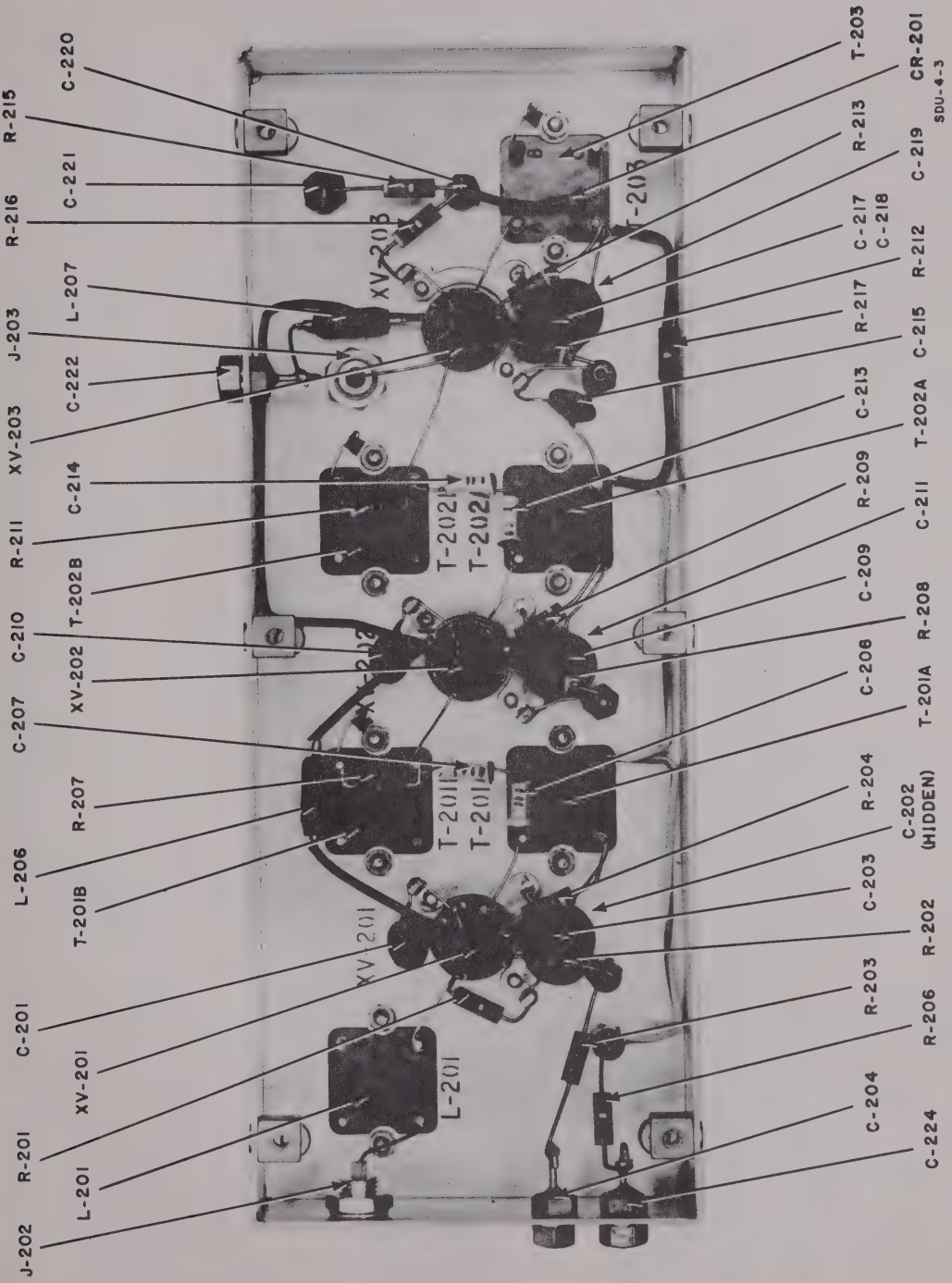


Figure 4–3. Preamplifier, Subtype A, Component Identification

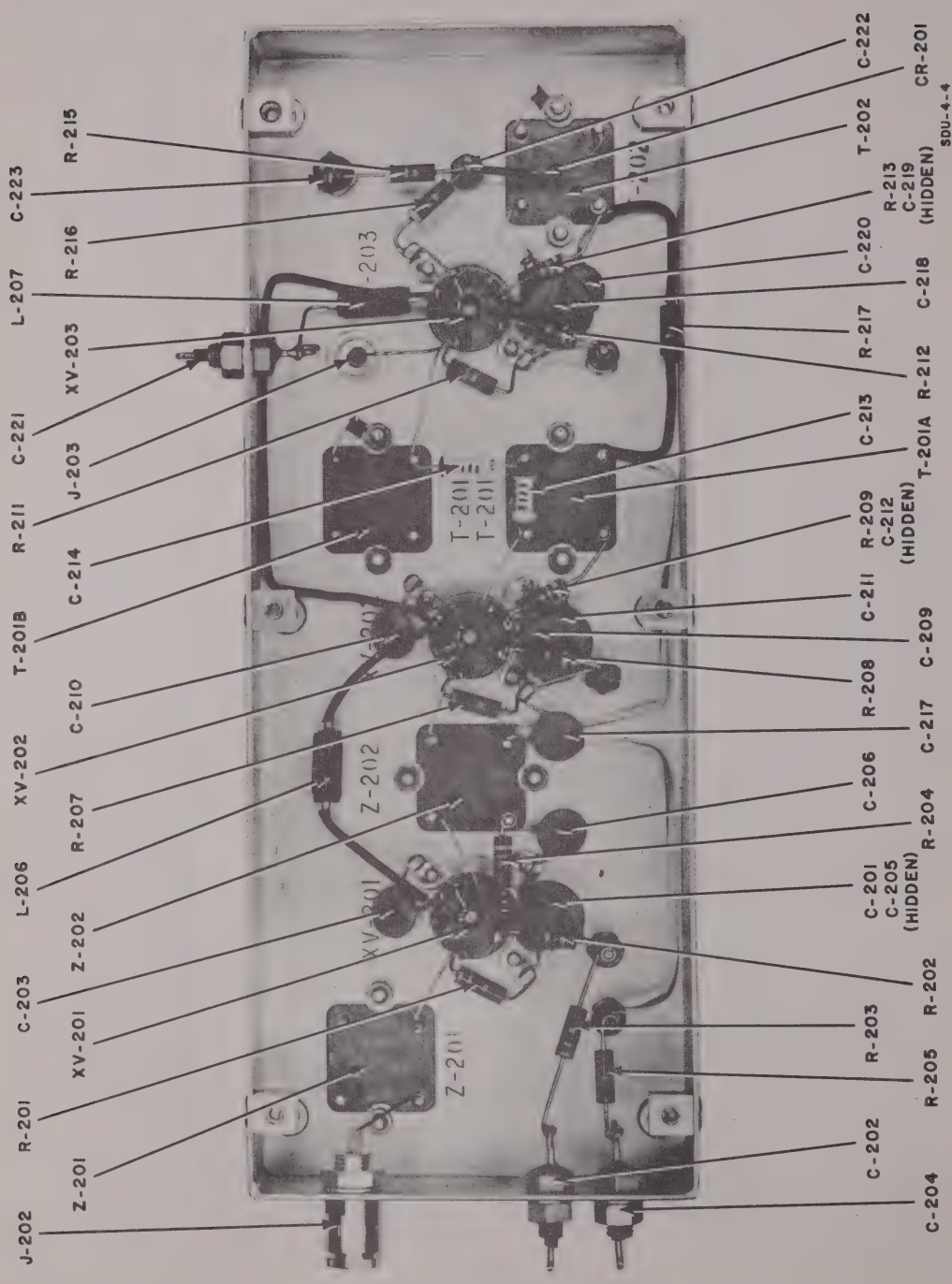


Figure 4–4. Preamplifier, Subtypes B and C, Component Identification

K4OG/WB4RHH
CHES WATKINS
P. O. BOX 3268
FT. PIERCE, FLA. 33450

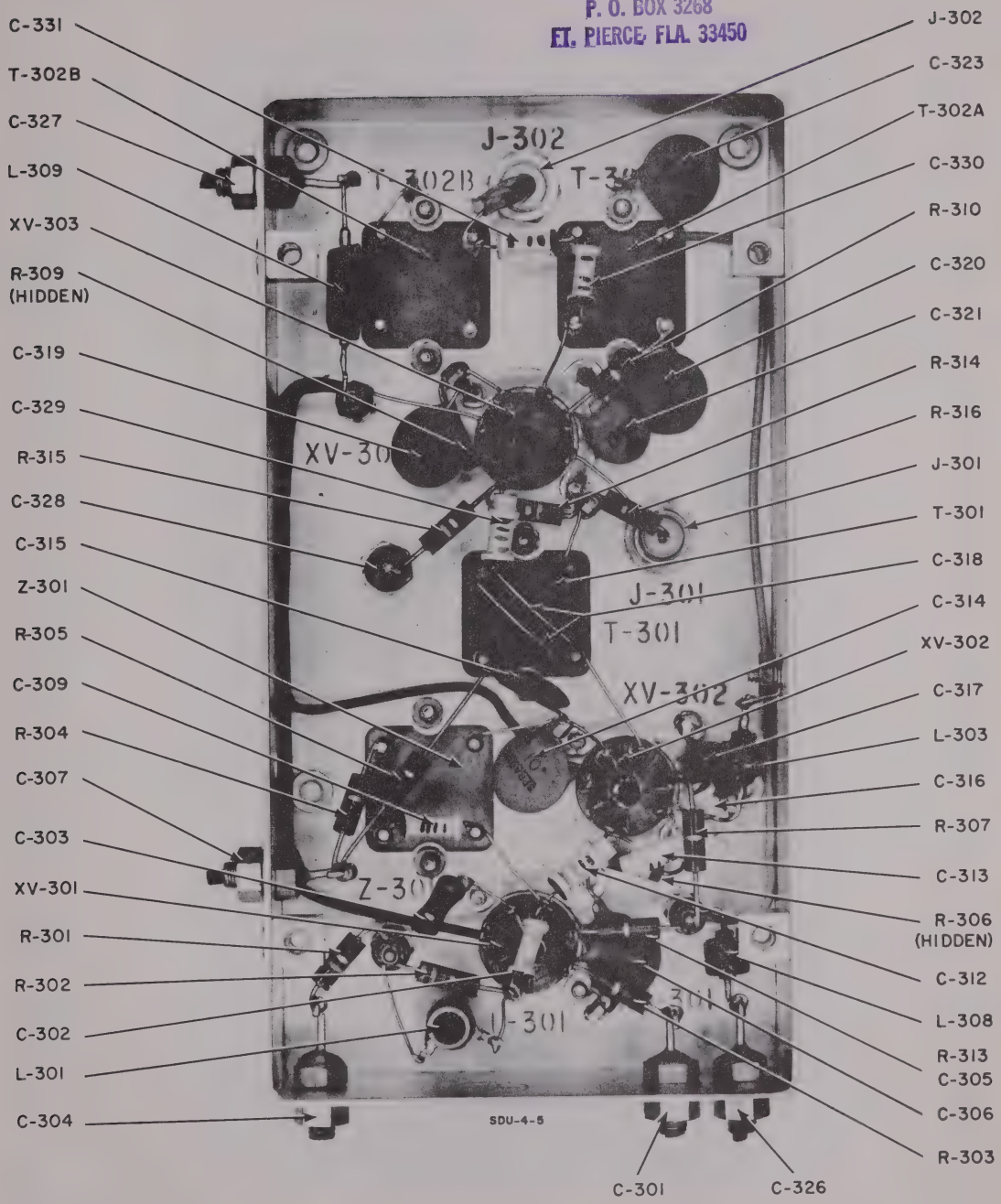


Figure 4–5. Local Oscillator Subchassis, SDU Types 200 and 300, Component Identification

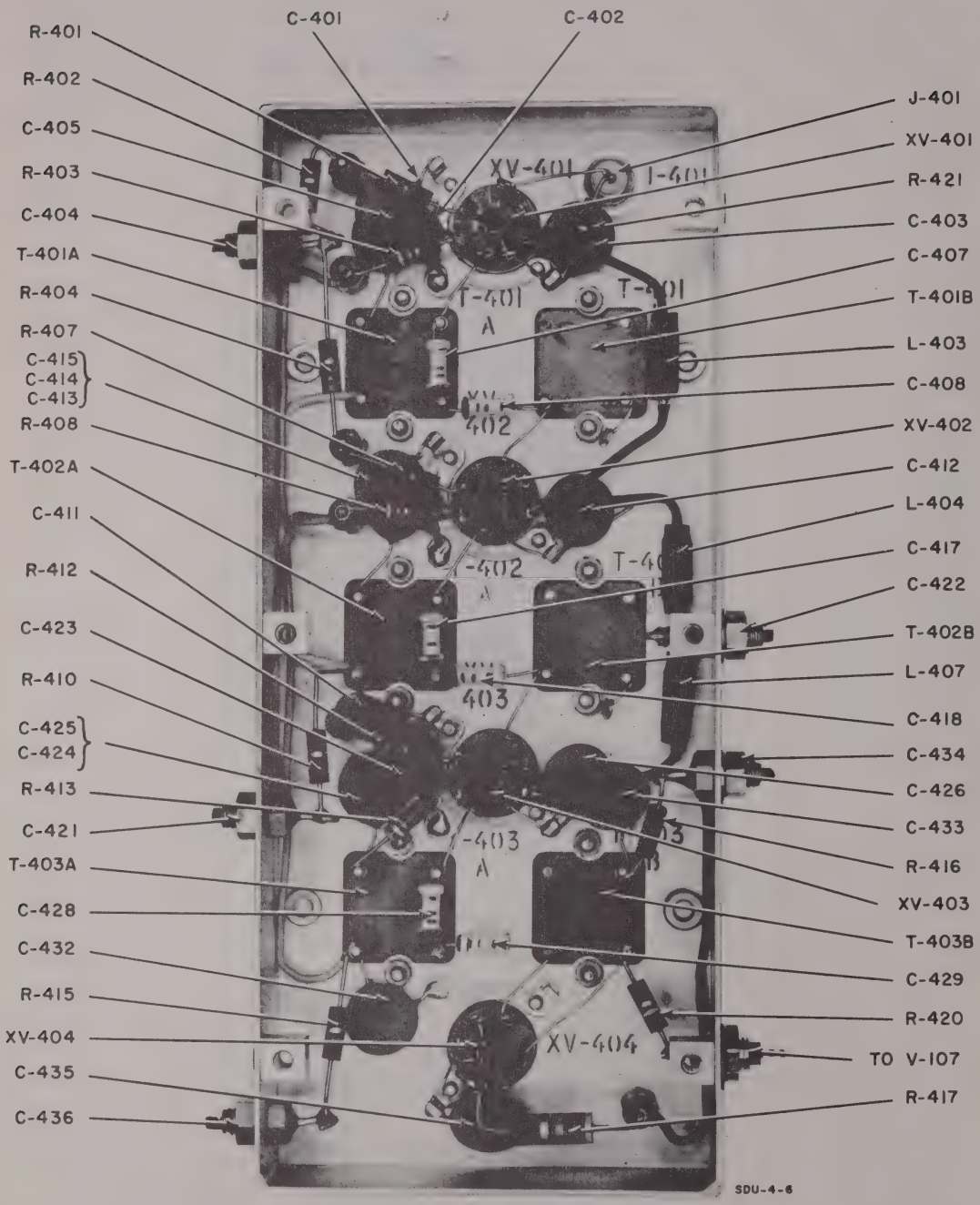


Figure 4–6. IF Amplifier, SDU Types 200 and 300, Component Identification

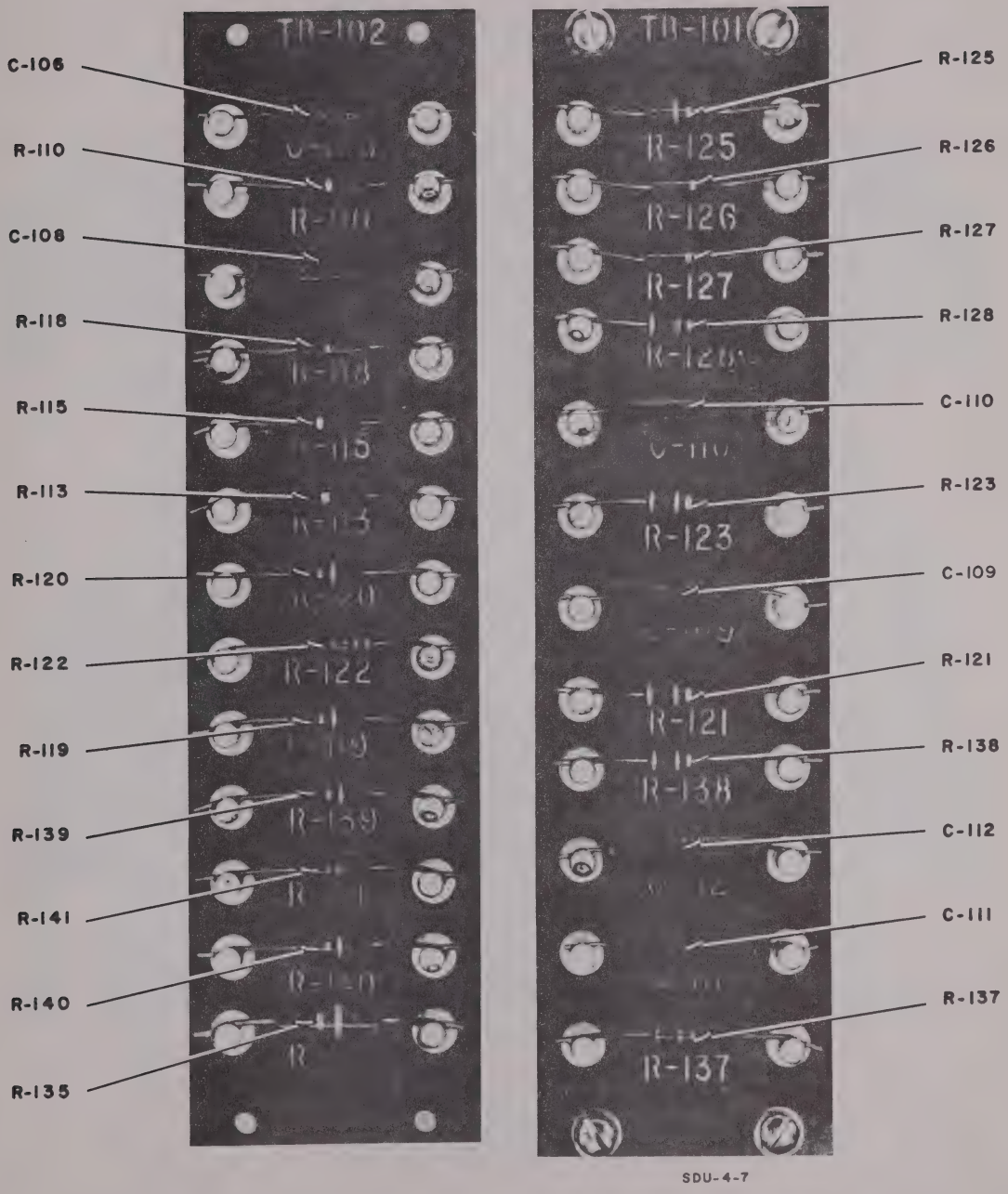
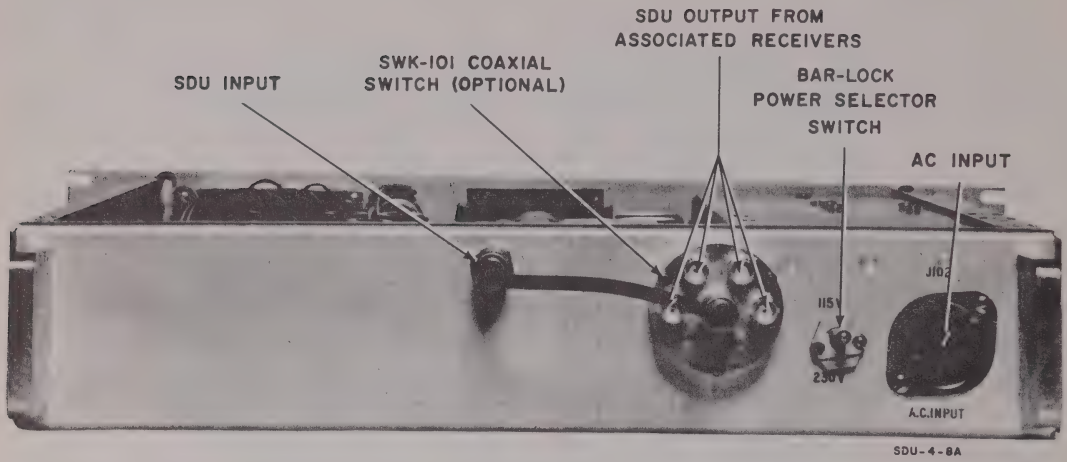
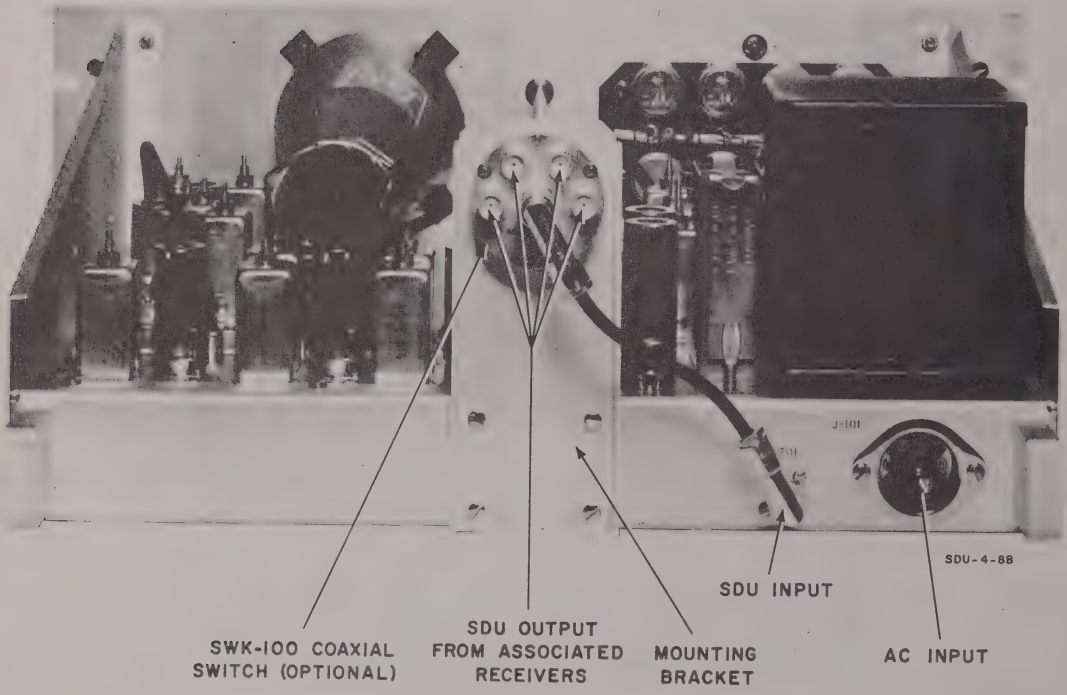


Figure 4–7. Terminal Boards, SDU Types 200 and 300, Component Identification



a. Type 350



b. Types 200 and 300

Figure 4–8. Rear Apron

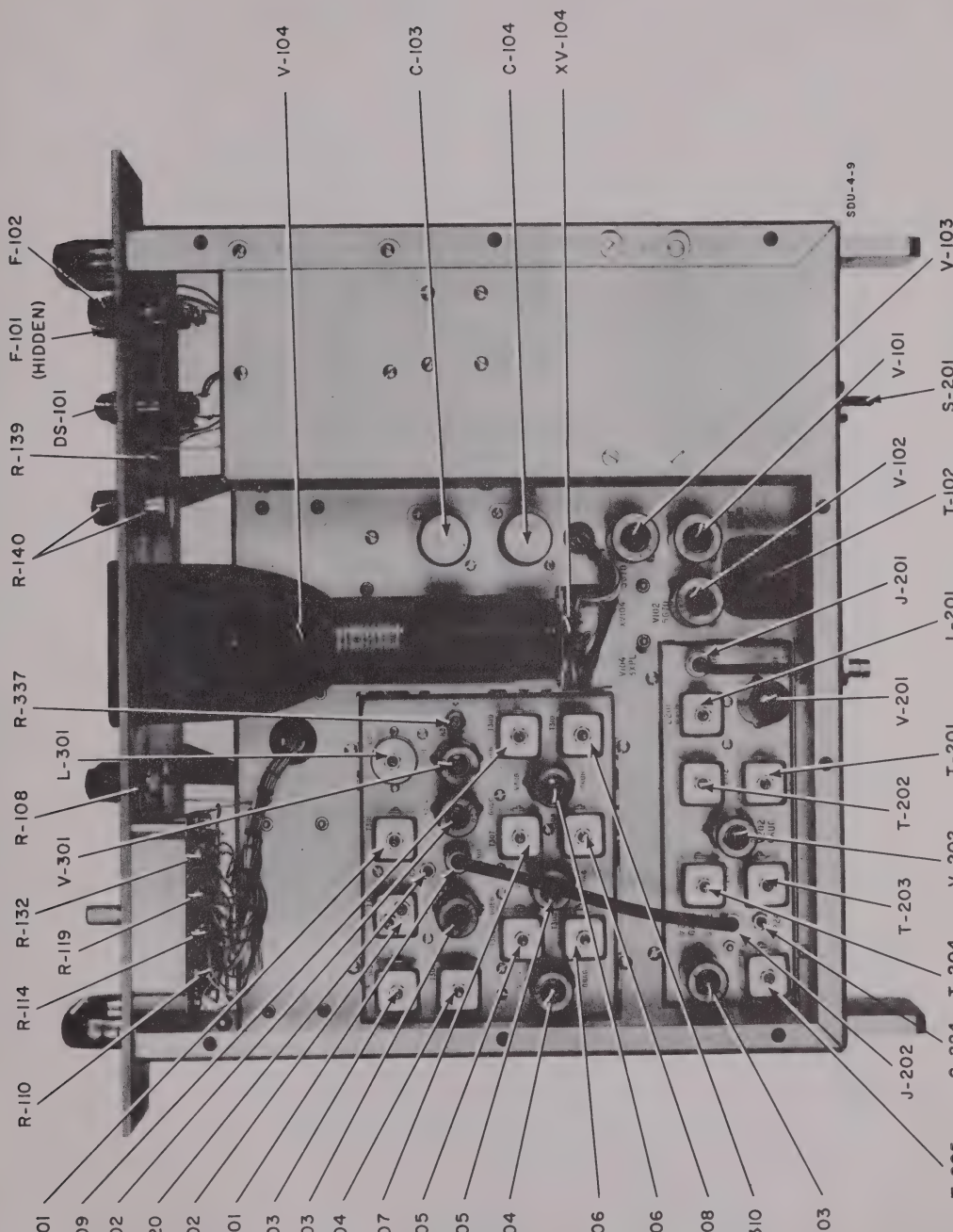


Figure 4–9. Top View, SDU Type 350, Component Identification

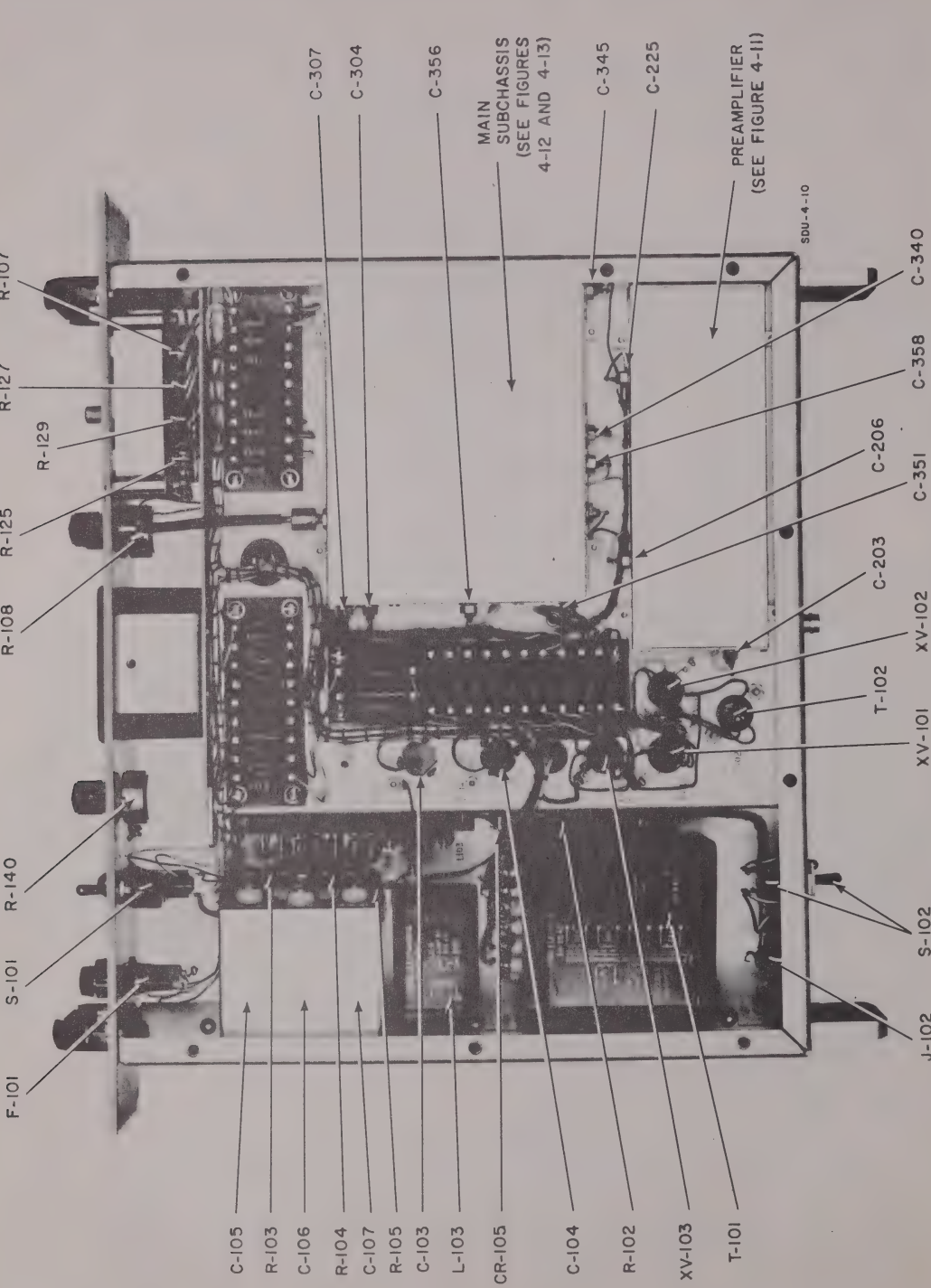


Figure 4–10. Bottom View, SDU Type 350, Component Identification

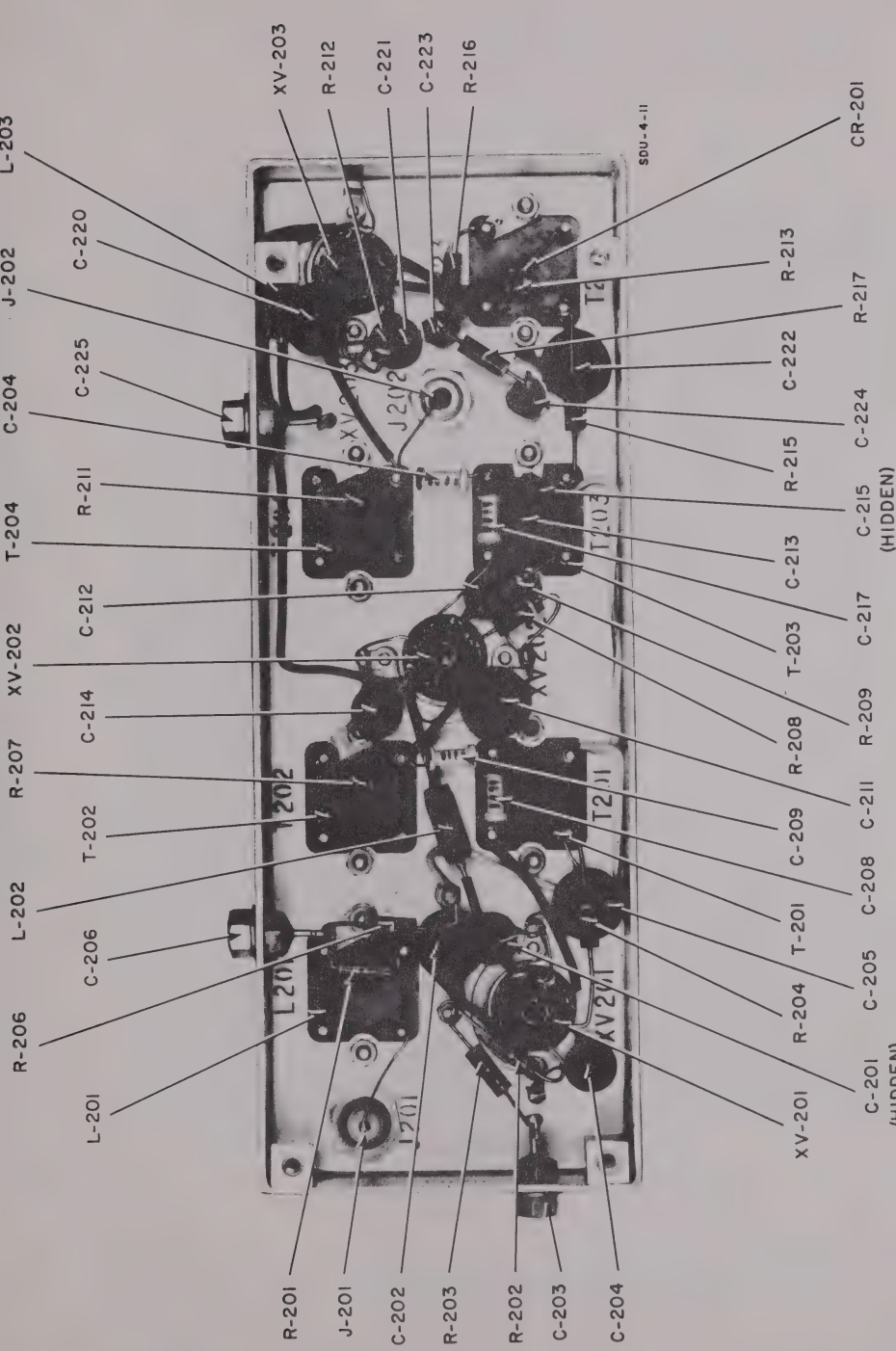


Figure 4–11. Preamplifier, SDU Type 350, Component Identification

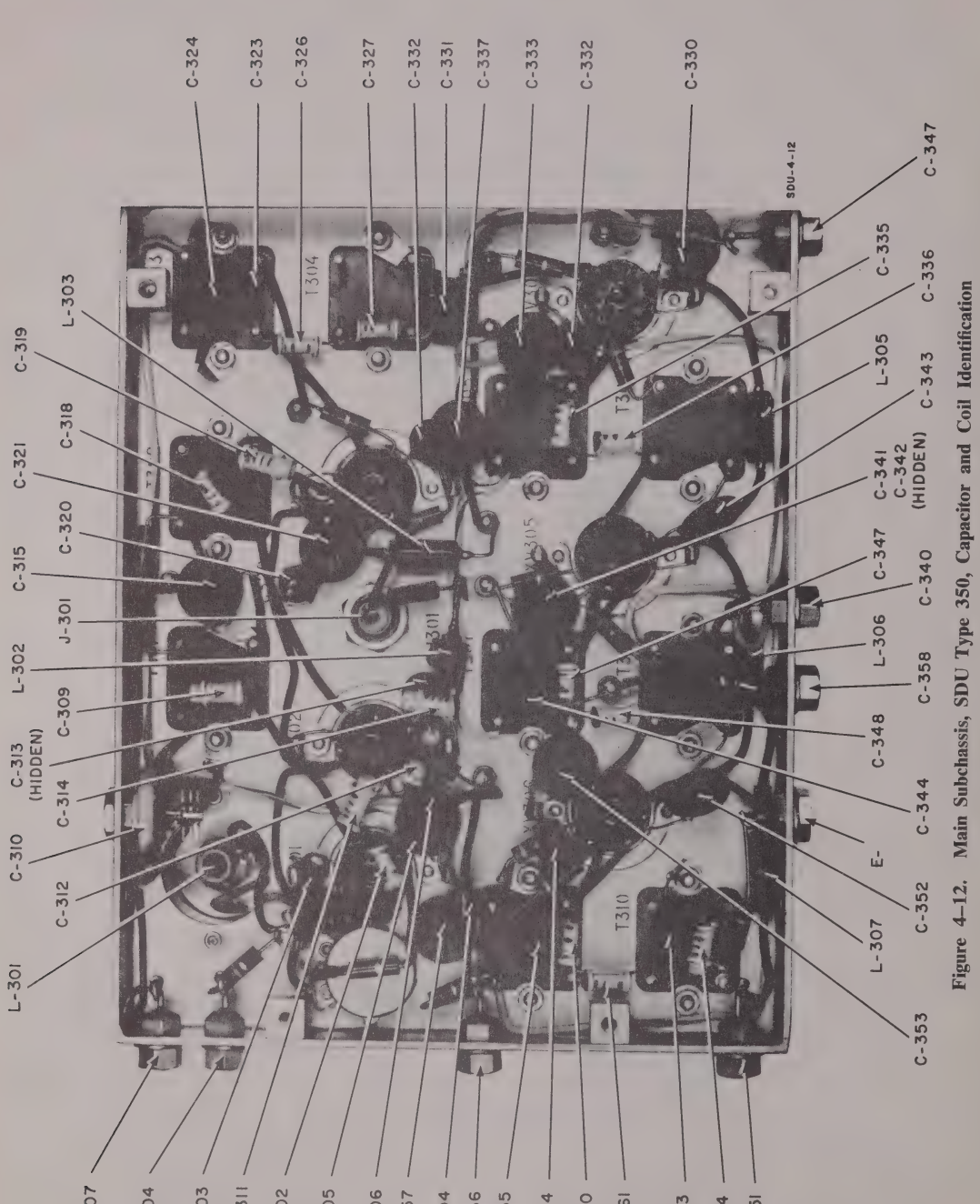


Figure 4–12. Main Subchassis, SDU Type 350, Capacitor and Coil Identification

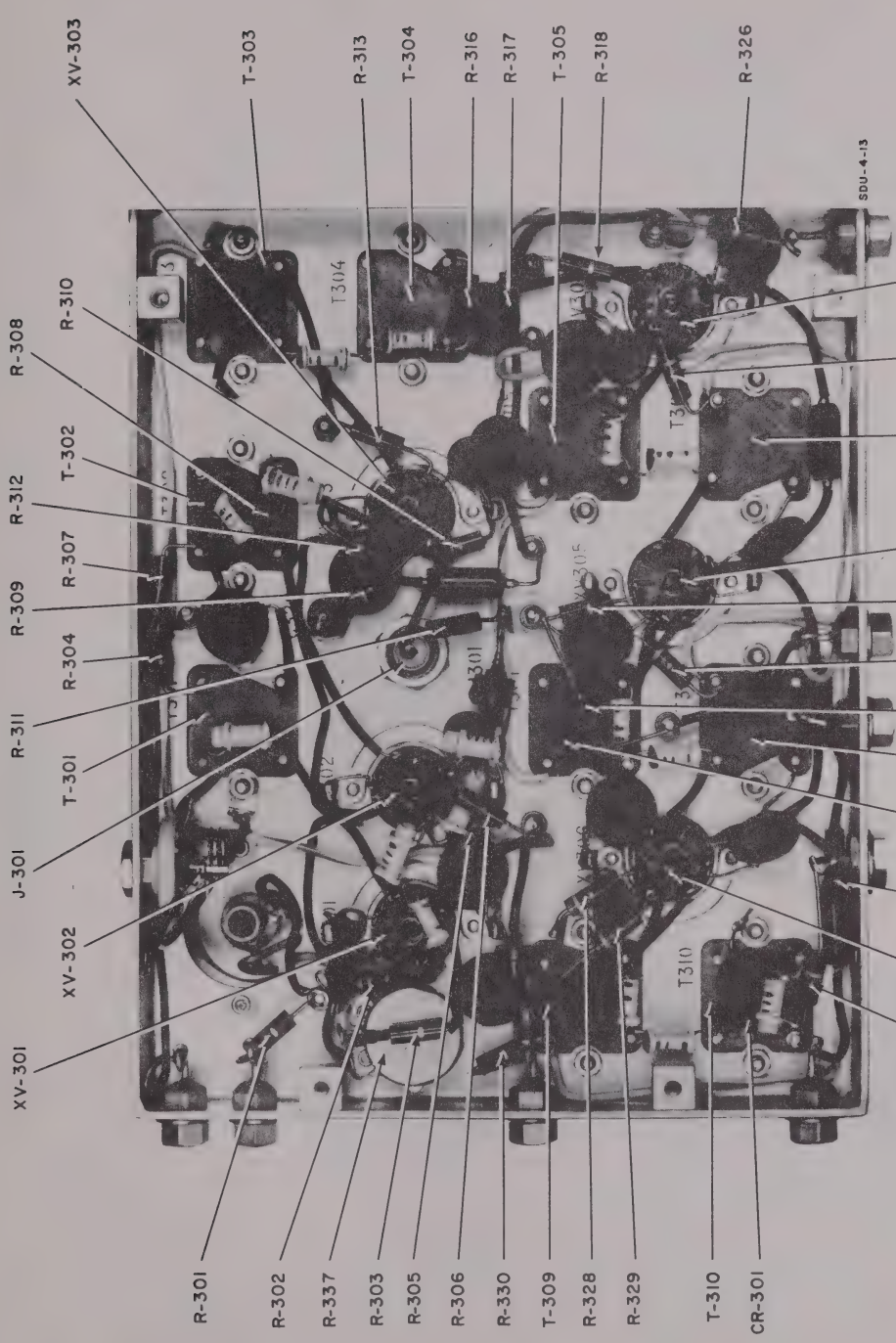


Figure 4-13. Main Subchassis, SDU Type 350, Resistor and Transformer Identification

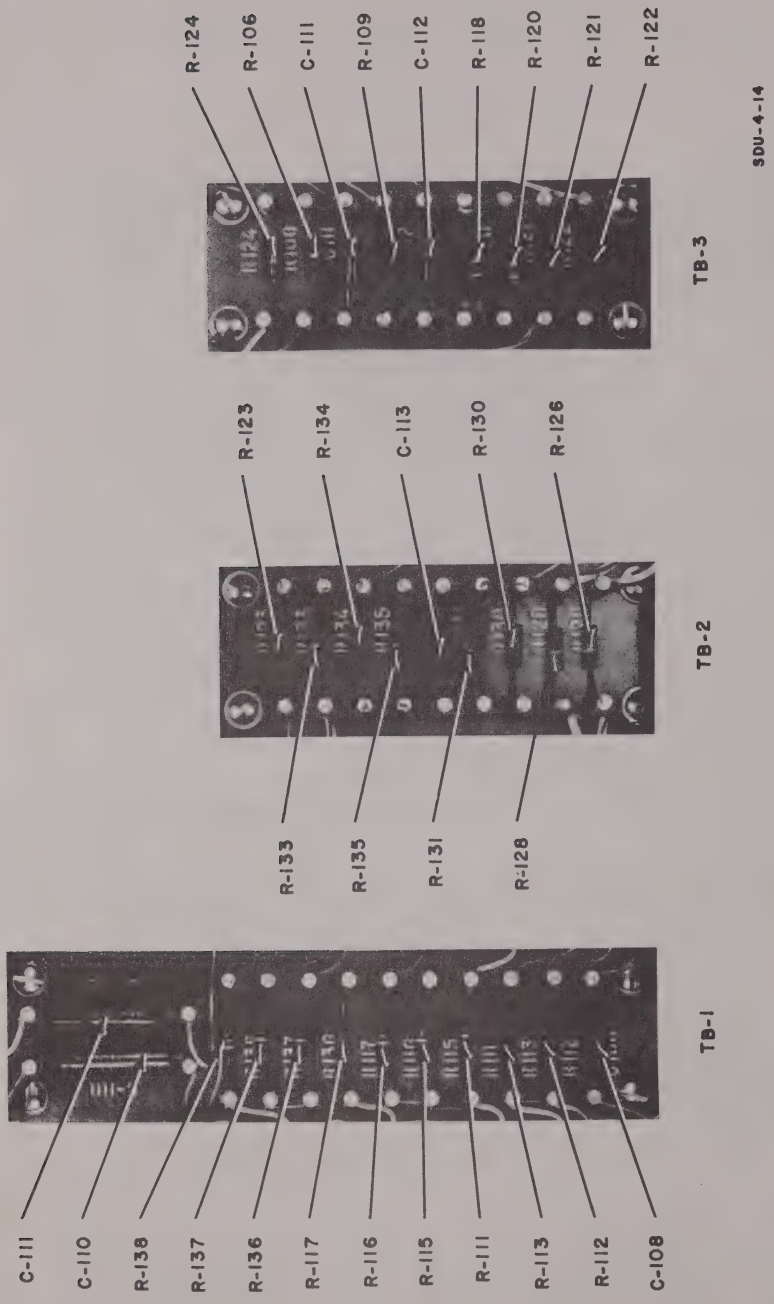


Figure 4–14. Terminal Boards, TB–1, TB–2 and TB–3, SDU Type 350, Component Identification

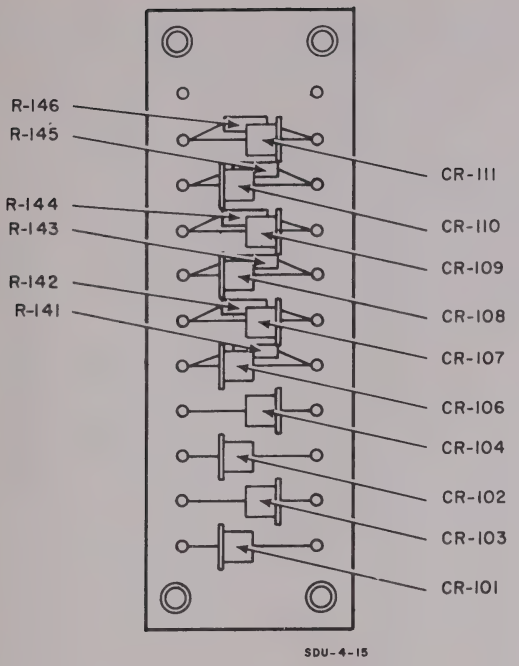


Figure 4–15. Terminal Board, TB–4, SDU Type 350, Component Identification

at fault. If this procedure does not locate the source of trouble, then the tube pin voltages should be checked against Tables 4–1 and 4–2 and the schematic diagrams, Figures 5–1 through 5–3. Any appreciable deviation from the listed values should indicate the circuitry at fault.

4.3 CATHODE RAY TUBE REPLACEMENT.

(1) Pull CRT socket from CRT base.

(2) Remove four screws holding bezel on front panel. Remove bezel and calibrated green filter screen from front panel.

(3) Pull rubber boot from face of CRT,

(4) Loosen base clamp of CRT. Remove CRT through front panel; the magnetic shield remains attached to the panel.

(5) Insert CRT through front panel into magnetic shield.

(6) Place rubber boot over face of CRT, positioned such that the rectangular boot opening is aligned with bezel and filter screen.

(7) Connect CRT socket to base of CRT.

(8) Install bezel and green filter screen on panel and tighten four mounting screws. Align boot opening with filter screen by pulling CRT away from bezel and rotating base of CRT.

(9) Turn on SDU and adjust for a well defined base line. Check alignment of CRT with filter screen. Rotate CRT, if needed, by turning its socket until the base line is parallel with the horizontal lines on the filter screen. Press forward lightly on CRT face while rotating to prevent simultaneous rotation of boot.

(10) After aligning base line with filter screen, press forward lightly on tube base and tighten base mounting clamp.

(11) Clean all fingerprints and dirt smudges from screen with clean, soft, dry cloth.

4.4 ALIGNMENT PROCEDURE, GENERAL.

Due to the different SDU input frequencies and bandwidths, the alignment procedure is divided into eight major steps. The alignment should be performed in the order given. Note that some sections of the alignment procedure are common to all SDU types while other sections apply to specific SDU types. If a component described in an alignment step bears a different symbol designation between SDU subtypes, the differences will be noted after the solid "bullet" (●) in the left margin. An explanation of the SDU subtype grouping is given in paragraph 2.3.

4.4.1 Alignment Procedure Sequence. The SDU must be aligned in the sequence outlined below:

(1) Horizontal Oscillator, all SDU types.

(2) Cathode Ray Tube Adjustments, all SDU types.

(3) IF Amplifier Alignment, all SDU types.

(4) Reactance Tube, Local Oscillator Alignment, all SDU types.

(5) Local Oscillator Transformer Alignment, all SDU types.

(6) Preamplifier Alignment (21.4 mc) all SDU types except types 200–3 and 300–3.

(7) Preamplifier Alignment (30 mc), types 200–3 and 300–3 only.

(8) Final Linearity Check, all SDU types.

4.4.2 Equipment Required. The following equipment, or equivalent, is required to align the SDU.

(1) Oscilloscope, DuMont 304–A

(2) RF Signal Generator, Hewlett-Packard Model 608–A

(3) RF Signal Generator, Measurements Corporation Model 65–B

(4) Sweep Generator, RCA Type WR–59C.

(5) Telemetry receiver associated with the SDU.

(6) Vacuum Tube Voltmeter.

(7) Assortment of 50 ohm coaxial cables and connectors.

(8) Small bottle of cement, General Cement No. 30 or 45

4.5 HORIZONTAL OSC. ADJUSTMENTS.

(1) Connect vertical amplifier of oscillator between cathode and ground.
- A,B,C: V–104 pin 3. D: V–101 pin 2.

(2) Connect horizontal amplifier of oscilloscope to 60 cps voltage appearing at feedthrough capacitor when using line frequency or to signal generator adjusted to 60 cps.
- A,B,C: C–422. D: C–351.

(3) On SDU, set SYNC control fully CW.

(4) Turn SYNC control slowly CCW and note where pattern locks, displaying two cycles of sine wave positioned vertically. Continue turning control slowly CCW until pattern just drops out of sync.

(5) Set the SYNC control midway between these two positions; lock the shaft nut.

(6) Disconnect oscilloscope.

4.6 CATHODE RAY TUBE ADJUSTMENTS.

(1) Check that CW rotation of INT control increases CRT trace brightness.

(2) Rotate CRT, if necessary, to position trace horizontally.

(3) Check that FOCUS and ASTIG controls offer best focus at other than at the limits of control rotation.

(4) Check that full CCW rotation of H GAIN control gives minimum CRT trace width.

(5) Check that CW rotation of H POS control moves CRT trace toward right side of screen.

(6) Check that full CW rotation of V POS control moves CRT trace to approximate center of screen and that full CCW rotation moves CRT trace below screen base line.

4.7 IF AMPLIFIER ALIGNMENT 4.3 mc.

(1) Disconnect cable connectors P–201 and J–301.

(2) Remove local oscillator tube, V–302.

(3) Connect shorting lead between capacitor and ground to short out dc voltage normally in series with detector output.
- A,B,C: C–434. D: C–358

(4) Set VTVM to + 12 volt range, and connect VTVM from grid to ground.
- A,B,C: V–107 pin 2. D: V–103 pin 3.

(5) At SDU, set GAIN control to full CW

(6) Adjust signal generator to 4.3 mc

(7) Connect signal generator output to pin C of transformer.
- A,B,C: T–402B. D: T–308

(8) Adjust transformers for peak VTVM reading.
- A,B,C: T–403A and T–403B. D: T–309 and T–310

(9) Adjust signal generator output level to maintain VTVM reading of approximately 5 volts. Reduce output level of signal generator to maintain VTVM reading of 5 vdc throughout the IF Amplifier Alignment procedure.

(10) Connect signal generator output to pin C of transformer
- A,B,C: T–401B. D: T–306

(11) Adjust transformers for peak VTVM reading.
- A,B,C: T–402A and T–402B. D: T–307 and T–308

(12 Connect signal generator output to pin C of transformer
- A,B,C: T–302B. D: T–304.

(13) Adjust transformers for peak VTVM reading.
- A,B,C: T–401A and T–401B. D: T–305 and T–306.

(14) Connect signal generator output to connector J–301.

(15) Adjust transformer for peak VTVM reading.
- A,B,C: T–302A and T–302B. D: T–303 and T–304.

(16) Install bottom covers on both preamplifier and IF strips and adjust all above transformers for maximum VTVM reading while maintaining signal generator output for VTVM reading of approximately 5 volts.

(17) Disconnect VTVM and signal generator.

(18) Remove shorting lead connected in step (3).

(19) Replace oscillator tube, V–302.

4.8 REACTANCE TUBE AND LOCAL OSCILLATOR ALIGNMENT.

(1) Turn ac power off.

(2) Set SDU controls as follows: GAIN, fully CW; SWEEP WIDTH, fully CW; CENTER FREQUENCY to index mark; SWEEP, fully CW; H GAIN, fully CCW; V POS, adjust for positioning of horizontal trace at CRT screen base line.

(3) Connect ohmmeter between potentiometer wiper and ground.

● A,B,C: R–101. D: R–337.

(4) Adjust potentiometer to 100 ohms.

● A,B,C: R–101. D: R–337.

(5) Remove ohmmeter and turn on SDU power.

(6) Connect signal generator to connector J–301 and tune to 21.4 or 30.0 mc depending upon type preamplifier used in SDU.

(7) Adjust signal generator output level and SDU GAIN until frequency marker is displayed at an amplitude equal to five lines on CRT grid, with low noise.

(8) Adjust FOCUS and ASTIG controls for best focus of horizontal and vertical trace.

(9) Adjust inductor until 21.4 or 30.0 mc marker remains exactly centered on CRT when SWEEP WIDTH control is turned fully CCW,

● A,B,C: Z–301. D: T–301.

(10) Adjust SWEEP WIDTH control until width of 21.4 or 30.0 mc marker occupies about ¼ of CRT trace.

(11) Adjust inductor L–301 until marker is positioned as far left on CRT trace as possible; readjust SWEEP WIDTH control as required to allow sharp tuning of L–301.

(12) Check that CW rotation of CENTER FREQUENCY control moves the 21.4 or 30.0 mc marker toward right side of CRT trace.

(13) If CENTER FREQUENCY control tunes correctly, reset index pointer to index panel, then adjust linkages between CENTER FREQUENCY control and capacitor such that rotor plates mesh halfway with stator plates.

● A,B,C: C–311. D: C–310.

(14) Repeat adjustment of inductors in steps (9), (10) and (11) until both are properly peaked.

(15) Set SWEEP WIDTH control fully CW.

(16) Modulate 608–A Signal Generator with 65–B.

● Signal Generator tuned to 1 mc for 200 series and type 350–7 SDU and 1.5 mc for 300 and 350 series SDU.

(17) Adjust SWEEP control until the 1.0 or 1.5 mc marker is positioned right of the center frequency marker (21.4 or 30.0 mc) approximately ⅛ inch from trace base line edge.

(18) Adjust H GAIN and H POS controls until center frequency marker is centered about zero point on CRT reticule screen and the 1.0 or 1.5 mc sideband marker is centered to right about the +1.0 or +1.5 point on the CRT reticule screen.

● Note position of left sideband marker in relation to —1.0 or —1.5 point on CRT reticule screen. Left sideband marker must not be more than ½ scale division from —1.0 or —1.5 point on CRT reticule screen.

(19) If linearity error of less than 0.5 scale divisions is noted, slowly turn SWEEP WIDTH control fully CCW and check that center frequency marker remains centered about zero on CRT reticule screen.

● If SDU passes step (19) test, proceed to local oscillator transformer alignment, paragraph 4.9.

(20) If linearity error of 0.5 scale divisions or more is noted, slowly adjust potentiometer (linearity control) until center frequency marker (21.4 or 30.0 mc) is centered between right and left 1.0 or 1.5 sideband markers.

● A,B,C: R–101. D: R–337

It is normal for all three markers to shift position slightly with reference to CRT reticule screen. H POS and H GAIN controls should not be readjusted at this time.

(21) The readjustment of the linearity control will affect the local oscillator center frequency; therefore, inductors in step (9) will require retuning.

● A,B,C: Z–301. D: T–301

(22) Disconnect 65–B modulating generator from 608–A generator.

(23) Tune 608–A Signal Generator to 21.4 or 30.0 mc depending upon SDU under alignment.

(24) Set SDU SWEEP control fully CW.

(25) Check that CENTER FREQUENCY control is set to index mark.

(26) Adjust inductors until center frequency marker remains exactly centered on CRT when SWEEP WIDTH control is turned fully CCW.

● A,B,C: Z–301. D: T–301

(27) Adjust SWEEP WIDTH control until width of center frequency marker occupies approximately ¼ of CRT trace.

(28) Adjust inductor L–301 until marker is positioned as far left on trace as possible.

(29) Readjust SWEEP WIDTH control as required to allow sharp tuning of L–301.

(30) Repeat sweep width calibration adjustment and sweep linearity check in steps (15) through (19).

(31) Disconnect signal generator from SDU.

4.9 LOCAL OSC. TRANS. ALIGNMENT.

(1) Remove bottom covers from all sub-chassis.

(2) Set SDU SWEEP control fully CW.

(3) Set SWEEP WIDTH control full CCW

(4) Set VTVM to —1.2 volt scale.

(5) Connect VTVM to junction of C–303 and R–301

(6) Turn SWEEP WIDTH control CW until a meter deflection is observed on the VTVM; then turn SWEEP WIDTH control CCW to the setting where the pointer on the VTVM just returns to zero.

(7) Connect vertical input of oscilloscope to feed-through capacitor.

● A,B,C: C–328. D: C–320.

(8) Adjust oscilloscope horizontal sweep frequency to display two complete cycles.

(9) Tune signal generator to 25.7 mc.

(10) Connect output of signal generator to J–301

(11) Adjust vertical gain and vertical position controls on oscilloscope until response curve occupies approximately 100 vertical units.

(12) Adjust signal generator output level until 25.7 mc marker is just visible on response curve.

(13) Adjust transformer primary and secondary until response is approximately centered around 25.7 mc marker.

● A,B,C: T–301. D: T–302A,B

(15) Readjust oscilloscope vertical gain as required to maintain response of 100 vertical units on CRT grid screen.

● For subtype D, go to step (20)

(16) Adjust spacing between bus wire leads on bottom of transformer T–301 for dip in response curve of 25 to 50%.

(17) Readjust primary and secondary of transformer T–301 as required to maintain response centering around 25.7 mc marker.

(18) Cement bus wire leads in place

(19) Readjust transformer T–301 as required to maintain correct tuning and bandwidth as cement dries.

(20) Measure oscillator bandwidth at 3–db points.

● Bandwidth should be approximately 3.6 mc.

(21) Install oscillator sub-chassis bottom cover and repeak transformer if detuning is noted.

● A,B,C: T–301. D: T–302A,B

4.10 PREAMPLIFIER ALIGNMENT (21.4 mc)

(1) Connect vertical input of oscilloscope to feed-through capacitor.

● A: C–331. C: C–223. D: C–224.

● Cable capacity plus oscilloscope input capacity should not exceed 100 uuf.

(2) Connect oscilloscope horizontal input to SYNC output of sweep generator.

● Proceed to step (5) for all SDU types except type 350–8.

(3) On SDU type 350–8 unsolder C–227 and R–219 from V–202 pin 1.

(4) Move the lead at L–204, which is connected to V–202 pin 1, to T–202 pin B.

(5) Connect sweep generator output to pin 1 of V–203

(6) Set SDU SWEEP WIDTH control fully CCW

(7) Set SDU GAIN control fully CW

(8) Adjust oscilloscope vertical sensitivity for 1-volt peak-to-peak.

(9) Adjust sweep generator output frequency to approximately 21.4 mc and the output level as required to produce response curve on oscilloscope.

(10) Couple in an accurate 21.4 mc marker as required to produce a suitable marker pip.

● Check that the marker signal does not upset response shape throughout alignment

(11) Adjust transformer for symmetrical response centered around 21.4 mc marker.

● A: T–203. C: T–202. D: T–205.

(12) Connect sweep generator output to pin 1 of V–202.

(13) Adjust transformers for symmetrical double peak response centered around 21.4 mc marker.

● A: T–202A,B. C: T–201A,B. D: T–203 and T–204.

(14) Adjust sweep generator output level as required to maintain 1-volt peak-to-peak deflection.

(15) Connect sweep generator output to pin 1 of V–201.

(16) Adjust transformers for double peaked response centered around 21.4 mc marker.

● A: T–201A,B. C: Z–202. D: T–201 and T–202.

(17) Readjust sweep generator output level as required to maintain 1-volt peak-to-peak deflection.

- Proceed to step (21) for all SDU types except type 350–8

(18) Reconnect C–227 and R–219 to V–202 pin 1.

(19) Remove the lead at pin B of T–202 which goes to V–201 pin 1 and reconnect to L–204.

(20) Tune L–204 for a peak centered at 21.4 mc.

- The response curve will have three peaks; the center peak will be lower in amplitude than the outer peaks.

(21) Turn associated telemetry receiver to power ON.

(22) Connect SDU output of associated receiver through 50-ohm coaxial cable to J–201 of SDU.

(23) Connect sweep generator to the RF test point located in the mixer grid of the associated receiver.

(24) Modulate Hewlett-Packard 608–A generator with Measurements 65–B generator and connect to feedthrough capacitor.

- A: C–221. B: C–223. D: C–224.

(25) For SDU series 200 and type 350–7, tune 65–B generator to 1.0 mc; for SDU series 300 and 350 (except 350–7), tune 65–B generator to 1.5 mc.

(26) Install 21.4 mc preamplifier bottom cover.

(27) Adjust inductor for peak response at 21.4 mc.

- A,C: Z–201. D: L–201
- Do not attempt to flatten response or remove large tilt in response with L–201/Z–201.

(28) Readjust sweep generator output level as required to maintain 1-volt peak-to-peak deflection.

(29) With 1 mc sideband markers for SDU series 200 and type 350–7 or 1.5 mc sideband markers for SDU series 300 and 350, except type 350–7, readjust for maximum flatness of IF response between sideband markers.

- A: T–201A,B and T–202A,B. C: Z–202 and T–201A,B. D: T–201, T–202, T–203 and T–204.
- The response should be adjusted to give equal amplitudes at both sideband markers. Approximately 6 peaks will be noted across response top; response beyond sideband markers is invalid. Do not readjust T–203 (subtype A), T–202 (subtype C), or T–205 (subtype D). Inductor L–201/Z–201 may require slight adjustment for peaking at 21.4 mc.

4.11 PREAMPLIFIER ALIGNMENT (30 mc).

(1) Connect vertical input of 304–A Oscilloscope to feedthrough C–223.

- Cable capacity plus oscilloscope input capacity should not exceed 100 uuf.

(2) Connect oscilloscope horizontal input to SYNC output of sweep generator.

(3) Connect sweep generator output to pin 1 of V–203.

(4) Set SDU SWEEP WIDTH control fully CCW

(5) Set SDU GAIN control fully CW

(6) Adjust oscilloscope vertical sensitivity for 1-volt peak-to-peak

(7) Adjust sweep generator output frequency to approximately 30 mc and the output level as required to produce response curve on oscilloscope.

(8) Couple in an accurate 30 mc marker as required to produce a suitable marker pip

- Check that marker signal does not disturb response shape throughout alignment

(9) Adjust T–202 for symmetrical response centered around 30.0 mc marker

- Response is normally round-nosed.

(10) Connect sweep generator output to pin 1 of V–202

(11) Adjust T–201A and T201B for symmetrical double peak response centered around 30.0 mc marker.

(12) Readjust sweep generator output level as required to maintain 1-volt peak-to-peak deflection.

(13) Connect sweep generator output to pin 1 of V–201

(14) Adjust Z–202 for peak response at 30.0 mc without regard to over-all response shape.

(15) Readjust sweep generator output level as required to maintain 1-volt peak-to-peak deflection

(16) Turn associated telemetry receiver power ON.

(17) Conncet SDU output of associated receiver through 50-ohm coaxial cable to J–201 on SDU.

(18) Connect sweep generator output to the RF test point located in the mixer grid of the receiver.

(19) Modulate Hewlett-Packard 608–A generator with Measurements 65–B generator.

(20) For SDU series 200, tune 65–B generator to 1.0 mc; for SDU series 300, tune 65–B generator to 1.5 mc.

(21) Install 30.0 mc preamplifier cover.

(22) Adjust Z–201 for peak response at 30.0 mc.

● Do not attempt to flatten response or remove a large tilt in response with Z–201.

(23) Readjust sweep generator output as required to maintain a 1-volt peak-to-peak deflection.

(24) With 1 mc sideband markers for SDU series 200 or 1.5 mc sideband markers for SDU series 300, readjust T–201A and T–201B for maximum flatness of IF response between sideband markers.

● The response should be adjusted to give equal amplitudes at both sideband markers. Approximately 6 peaks will be noted across the response top; the response beyond sideband markers is normally ignored. T–202 should not be readjusted. Z–201 and Z–202 may require a slight adjustment, but should only be adjusted for a 30 mc response peak.

4.12 FINAL LINEARITY CHECK.

(1) Set CENTER FREQUENCY control to the panel reference mark.

(2) Set the SWEEP control fully CW

(3) Set the SWEEP WIDTH control fully CW

(4) Tune signal generator to 21.4 mc or 30.0 mc depending on SDU type

(5) Connect signal generator to J–201 jack of SDU

(6) Adjust signal generator output level and SDU GAIN control until marker is displayed at height of 5 lines on the CRT screen with low noise.

(7) Adjust Z–301 in SDU series 200 and 300 (T–301 in SDU series 350) until marker remains exactly centered on CRT when SWEEP WIDTH control is turned fully CCW

● The above transformers should require only a slight adjustment.

(8) Modulate the Hewlett-Packard 608–A generator with the Measurements 65–B generator accurately tuned to 1.0 mc or 1.5 mc depending upon the SDU type.

(9) Set SWEEP WIDTH control fully CW

(10) Adjust SWEEP control until sideband marker to the right of the center marker is positioned about the +1.0 or +1.5 point on the CRT grid screen, depending on the SDU type. Check point on the CRT grid screen, depending on the SDU type. Check position of left sideband marker. It must not be more than ½ scale division from the −1.0 or −1.5 point on the CRT grid screen.

(11) Lock controls.

Chapter 5
Replacement Parts List

5.1 When ordering replacement parts, give the equipment name and model number, and the symbol number and description of each item ordered. Replacement parts supplied against an order may not be exact duplicates of the original. However, only minor differences in the electrical or mechanical characteristics will be involved, and, consequently, the operation and performance of the equipment will in no way be altered or impaired.

5.2 The various SDU's are grouped in subtypes as follows:

Subtype A	Subtype B	Subtype C	Subtype D
SDU-200-1	SDU-200-3	SDU-300-5	SDU-350-6
SDU-200-2	SDU-300-3		SDU-350-7
SDU-200-7			SDU-350-8
SDU-300-1			
SDU-300-4			
SDU-300-6			

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
C-101A, B, C	C-101A, B, C	C-101A, B, C		CAPACITOR, FIXED, ELECTROLYTIC: 20-20-20 μf 450V, Sprague PE-3780
			C-101	NOT USED
C-102A, B, C	C-102A, B, C	C-102A, B, C		CAPACITOR, FIXED, ELECTROLYTIC: 20-20-20 μf 450V, Sprague PE-3780
			C-102	NOT USED
C-103	C-103	C-103		CAPACITOR, FIXED, PAPER: 2 μf ±10% 600V, Sprague CP70E1EF205K
			C-103	CAPACITOR, FIXED, ELECTROLYTIC, DIELECTRIC: 20 μf 450V, Sprague DEP1714
C-104	C-104	C-104		CAPACITOR, FIXED, PAPER: 1 μf ±10% 1000V, Sprague CP70E1EG105K
			C-104	Same as C-103
C-105	C-105	C-105		Same as C-104
			C-105	CAPACITOR, FIXED, PAPER DIELECTRIC: 0.5 μf ±10% 2000V, Sprague 7120-5
C-106	C-106	C-106		CAPACITOR, FIXED, PAPER: 0.01 μf ±10% 200V, Aerovox P123ZGP
			C-106	Same as C-105
C-107	C-107	C-107		CAPACITOR, FIXED, PAPER: 0.25 μf ±10% 200V, Aerovox P123ZGP
			C-107	Same as C-105
C-108	C-108	C-108		CAPACITOR, FIXED, PAPER: 0.047 μf ±10% 200V, Aerovox P123ZGP

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			C-108	CAPACITOR, FIXED, PAPER: 0.01 μf ±10% 200V, Aerovox P123ZGP
C-109	C-109	C-109		CAPACITOR, FIXED, PAPER: 0.1 μf ±10% 200V, Aerovox, P123ZGP
			C-109	CAPACITOR, FIXED, PAPER: 0.25 μf ±10% 200V, Aerovox P123ZGP
C-110	C-110	C-110		Same as C-109
			C-110	Same as C-109
C-111	C-111	C-111		Same as C-109
			C-111	CAPACITOR, FIXED, PAPER: 0.047 μf ±10% 200V, Aerovox P123ZGP
C-112	C-112	C-112		Same as C-109
			C-112	CAPACITOR, FIXED, PAPER DIELECTRIC: 0.1μf ±10% 200V, Aerovox P123ZGP
C-113	C-113	C-113		CAPACITOR, FIXED, CERAMIC: 470 μμf ±10% 500V, Erie GP2-331
			C-113	Same as C-112
C-114	C-114	C-114		Same as C-113
			C-114	CAPACITOR, CERAMIC, DIELECTRIC: 470 μμf ±10% 500V, Erie GP2-331
C-115	C-115	C-115		NOT USED
			C-115	Same as C-114
C-201				CAPACITOR, CERAMIC, DISC: 0.0047 μf GMV 500V, Sprague 2-C8
	C-201	C-201		CAPACITOR, FIXED, CERAMIC: 0.01 μf GMV 500V, Sprague 29C9B8
			C-201	CAPACITOR, FIXED, CERAMIC, DIELECTRIC: 0.0047 μf GMV 500V, Sprague 20C8
C-202			C-202	CAPACITOR, CERAMIC, DISC: 0.01 μf GMV 500V, Sprague 29C9B8
	C-202	C-202		CAPACITOR, FIXED, CERAMIC, FEEDTHRU: 0.001 μf GMV 500V, Sprague 514C1
C-203				Same as C-202
	C-203	C-203		CAPACITOR, CERAMIC, DISC: 0.0047 μf GMV 500V, Sprague 20C8
			C-203	CAPACITOR, FIXED, CERAMIC, DIELECTRIC: 0.001 μf 500V, Sprague 514C1
C-204				CAPACITOR, FIXED, CERAMIC, FEEDTHRU: 0.001 μf GMV 500V, Sprague 514C1
	C-204	C-204		Same as C-202
			C-204	Same as C-201

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
C-205*				CAPACITOR: p/o T-201A
	C-205	C-205		Same as C-203
			C-205	Same as C-202
C-206				CAPACITOR, CERAMIC: 10 μμf ±1 μμf 500V, Erie NPO-A (SDU-Types 200-1, 200-2, 200-7)
				CAPACITOR, CERAMIC: 15 μμf ±5% 500V, Erie NPO-A (SDU-Types 300-1, 300-4, 300-6)
	C-206			Same as C-203
		C-206		Same as C-201
			C-206	Same as C-203
C-207				CAPACITOR, CERAMIC: 15 μμf ±5% 500V, Erie NPO-A (SDU-Type 200-1)
				CAPACITOR, CERAMIC: 10 μμf ±1 μμf 500V, Erie NPO-A (SDU-Type 200-7)
				CAPACITOR, CERAMIC: 12 μμf ±5% 500V, Erie NPO-A (SDU-Type 200-2)
				CAPACITOR, CERAMIC: 22 μμf ±5% 500V, Erie NPO-A (SDU-Types 300-1, 300-4, 300-6)
	C-207*	C-207*		CAPACITOR: p/o Z-202
			C-207*	CAPACITOR: p/o T-201
C-208*				CAPACITOR: p/o T-201B
	C-208*	C-208*		CAPACITOR: p/o Z-202
			C-208	CAPACITOR, CERAMIC: 8.2 μμf ±5% 500V, Erie 8R2, Type-301 (SDU-Type 350-7)
				CAPACITOR, CERAMIC: 18 μμf ±5% 500V, Erie NPO-A (SDU-Types 350-6, 350-8)
C-209				Same as C-202
	C-209	C-209		Same as C-201
			C-209	CAPACITOR, CERAMIC: 22 μμf ±5% 500V, Erie NPO-A (SDU-Types 350-6, 350-8)
			C-209	Same as C-208 (SDU-Type 350-7)
C-210				Same as C-201
	C-210	C-210		Same as C-203
			C-210*	CAPACITOR: p/o T-202
C-211			C-211	Same as C-202
	C-211	C-211		Same as C-201
C-212*				CAPACITOR: p/o T-202A
	C-212	C-212		Same as C-203
			C-212	Same as C-201

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
C-213				CAPACITOR, CERAMIC: 10 μμf ±1 μμf 500V, Erie NPO-A (SDU-Types 200-1, 300-1, 300-4)
				CAPACITOR, CERAMIC: 6.8 μμf ±0.5 μμf 500V, Erie NPO-A (SDU-Types 200-2, 200-7)
				CAPACITOR, CERAMIC: 12 μμf ±5% 500V, Erie NPO-A (SDU-Type 300-6)
	C-213			CAPACITOR, CERAMIC: 10 μμf ±5% 500V, Erie NPO-A
		C-213		CAPACITOR, CERAMIC: 22 μμf ±5% 500V, Erie NPO-A
			C-213	Same as C-202
C-214				CAPACITOR, FIXED, CERAMIC: 10 μμf ±1% 500V, Erie NPO-A (SDU-Types 200-1, 200-2, 200-7)
				CAPACITOR, FIXED, CERAMIC: 18 μμf ±5% 500V, Erie NPO-A (SDU-Types 300-1, 300-4)
				CAPACITOR, FIXED, CERAMIC: 15 μμf ±5% 500V, Erie NPO-A (SDU-Type 300-6)
	C-214			Same as C-213
		C-214		CAPACITOR, CERAMIC: 18 μμf ±5% 500V, Erie NPO-A
			C-214	Same as C-201
C-215				Same as C-201
	C-215*	C-215*		CAPACITOR: p/o T-201A
			C-215	Same as C-201
C-216*				CAPACITOR: p/o T-202B
	C-216*	C-216*		CAPACITOR: p/o T-201B
			C-216*	CAPACITOR: p/o T-203
C-217				Same as C-202
	C-217	C-217		Same as C-203
			C-217	Same as C-208
C-218	C-218	C-218		Same as C-201
			C-218	Same as C-208
C-219				Same as C-202
	C-219	C-219		Same as C-203
			C-219*	CAPACITOR: p/o T-204
C-220				CAPACITOR, CERAMIC, STANDOFF: 470 μμf GMV 500V, Sprague 507C8A
	C-220			Same as C-203
		C-220		Same as C-201
			C-220	Same as C-202
C-221				CAPACITOR, CERAMIC, FEEDTHRU: 47 μμf ±20% GA Sprague 514C11A

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
	C-221	C-221		Same as C-202
			C-221	Same as C-201
C-222				Same as C-204
	C-222	C-222		CAPACITOR, CERAMIC: 470 μμf GMV 500V, Sprague 507C8
			C-222	Same as C-202
C-223				Same as C-201
	C-223	C-223		CAPACITOR, CERAMIC, FEEDTHRU: 47 μμf ±20% 500V, Sprague 514C11A
			C-223	CAPACITOR, CERAMIC, DIELECTRIC: 470 μμf GMV 500V, Sprague 507C8
C-224				Same as C-204
	C-224	C-224		NOT USED
			C-224	CAPACITOR, CERAMIC, DIELECTRIC: 47 μμf ±20% 500V, Sprague 514C11A
C-225				Same as C-201
	C-225	C-225		NOT USED
			C-225	Same as C-203
C-226	C-226	C-226		NOT USED
			C-226	NOT USED (SDU-Types 350-6 and 350-7)
				CAPACITOR: p/o T-202 (SDU-Type 350-8)
C-227	C-227	C-227		NOT USED
			C-227	CAPACITOR, MICA: 33 μμf ±5% 300V, Elmenco CM15D330J (SDU-Type 350-8 only)
C-301	C-301	C-301		Same as C-202
			C-301	NOT USED
C-302	C-302	C-302	C-302	CAPACITOR, CERMAIC, DIELECTRIC: 3.9 μμf ±0.25 μμf 500V, Erie NPO-A
C-303	C-303	C-303		CAPACITOR, CERAMIC, DIELECTRIC: 0.001 μf ±10% 500V, Erie GP2-331
			C-303	CAPACITOR, CERAMIC: 1000 μμf ±20% 500V, Erie GP2-332
C-304				CAPACITOR, CERAMIC, FEEDTHRU: 47 μμf ±20% 500V, Sprague 514C11A
	C-304	C-304		Same as C-223
			C-304	Same as C-224
C-305			C-305	Same as C-202
	C-305	C-305		Same as C-201
C-306			C-306	Same as C-201

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
	C-306	C-306		Same as C-203
C-307				Same as C-204
	C-307	C-307		Same as C-202
			C-307	Same as C-203
C-308*	C-308*	C-308*		CAPACITOR: p/o Z-301
			C-308*	CAPACITOR: p/o T-301
C-309	C-309	C-309		CAPACITOR, CERAMIC: 15 μμf ±5% 500V, Erie NPO-A
			C-309	CAPACITOR, CERAMIC, DIELECTRIC: 33 μμf ±5% 500V, Erie NPO-T
C-310	C-310	C-310		NOT USED
			C-310	CAPACITOR, VARIABLE, AIR DIELECTRIC: 1.3-5.4 μμf 500V, Erie NPO-A
C-311	C-311	C-311		CAPACITOR, VARIABLE, AIR DIELECTRIC: 1.3-5.4 880V rms, Hammarlund MAC-5
			C-311	Same as C-309
C-312	C-312	C-312		CAPACITOR, CERAMIC: 33 μμf ±5% 500V, Erie NPO-T
			C-312	Same as C-309
C-313	C-313	C-313		Same as C-312
			C-313	Same as C-201
C-314	C-314	C-314		Same as C-201
			C-314	Same as C-309
C-315	C-315	C-315		Same as C-201
			C-315	Same as C-202
C-316	C-316	C-316		Same as C-312
			C-316*	CAPACITOR: p/o T-302A
C-317				Same as C-201
	C-317	C-317		Same as C-203
			C-317*	CAPACITOR: p/o T-302B
C-318*	C-318*	C-318*		CAPACITOR: p/o T-301
			C-318	CAPACITOR, CERAMIC, DIELECTRIC: 0.5 μμf ±0.25 μμf 500V, Erie CC20CK0R5C
C-319				Same as C-202
	C-319	C-319		Same as C-201
			C-319	Same as C-309
C-320				Same as C-202
	C-320	C-320		Same as C-201
			C-320	Same as C-224
C-321				Same as C-201

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
	C-321	C-321		Same as C-203
			C-321	CAPACITOR, CERAMIC, DIELECTRIC: 0.01 μf GMV Sprague 29C9B6
C-322*	C-322*	C-322*		CAPACITOR: p/o T-302A
			C-322	Same as C-201
C-323				Same as C-202
	C-323	C-323		Same as C-201
			C-323	Same as C-321
C-324*	C-324*	C-324*		CAPACITOR: p/o T-302B
			C-324	Same as C-321
C-325*	C-325*	C-325*		CAPACITOR: p/o T-302B
			C-325*	CAPACITOR: p/o T-303
C-326				Same as C-204
	C-326	C-326		Same as C-202
			C-326	CAPACITOR, CERAMIC, DIELECTRIC: 1.5 μμf ±0.1 μμf 500V, Erie NPO-A
C-327				Same as C-204
	C-327	C-327		Same as C-202
			C-327	Same as C-326
C-328				Same as C-221
	C-328	C-328		Same as C-223
			C-328*	CAPACITOR: p/o T-304
C-329	C-329	C-329		Same as C-312
			C-329*	CAPACITOR: p/o T-304
C-330	C-330	C-330		CAPACITOR, CERAMIC: 1.5 μμf ±0.1 μμf 500V, Erie NPO-A
			C-330	Same as C-202
C-331	C-331	C-331		Same as C-330
			C-331	Same as C-202
C-332	C-332	C-332		NOT USED
			C-332	Same as C-201
C-333	C-333	C-333		NOT USED
			C-333	Same as C-202
C-334	C-334	C-334		NOT USED
			C-334*	CAPACITOR: p/o T-307
C-335	C-335	C-335		NOT USED
			C-335	Same as C-326
C-336	C-336	C-336		NOT USED

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			C-336	Same as C-326
C-337	C-337	C-337		NOT USED
			C-337	Same as C-202
C-338	C-338	C-338		NOT USED
			C-338*	CAPACITOR: p/o T-306
C-339	C-339	C-339		NOT USED
			C-339*	CAPACITOR: p/o T-306
C-340	C-340	C-340		NOT USED
			C-340	Same as C-203
C-341	C-341	C-341		NOT USED
			C-341	Same as C-202
C-342	C-342	C-342		NOT USED
			C-342	Same as C-201
C-343	C-343	C-343		NOT USED
			C-343	Same as C-202
C-344	C-344	C-344		NOT USED
			C-344	Same as C-202
C-345	C-345	C-345		NOT USED
			C-345	Same as C-203
C-346	C-346	C-346		NOT USED
			C-346*	CAPACITOR: p/o T-307
C-347	C-347	C-347		NOT USED
			C-347	Same as C-326
C-348	C-348	C-348		NOT USED
			C-348	Same as C-326
C-349	C-349	C-349		NOT USED
			C-349*	CAPACITOR: p/o T-308
C-350	C-350	C-350		NOT USED
			C-350*	CAPACITOR: p/o T-308
C-351	C-351	C-351		NOT USED
			C-351	Same as C-203
C-352	C-352	C-352		NOT USED
			C-352	Same as C-202
C-353	C-353	C-353		NOT USED
			C-353	Same as C-202
C-354	C-354	C-354		NOT USED

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			C-354	Same as C-201
C-355	C-355	C-355		NOT USED
			C-355	Same as C-202
C-356	C-356	C-356		NOT USED
			C-356	Same as C-203
C-357	C-357	C-357		NOT USED
			C-357	Same as C-202
C-358	C-358	C-358		NOT USED
			C-358	Same as C-203
C-359	C-359	C-359		NOT USED
			C-359*	CAPACITOR: p/o T-309
C-360	C-360	C-360		NOT USED
			C-360	Same as C-326
C-361	C-361	C-361		NOT USED
			C-361	CAPACITOR, CERAMIC: 1.2 μμf ±0.1 μμf 500V, Erie NPO-A
C-362	C-362	C-362		NOT USED
			C-362*	CAPACITOR: p/o T-310
C-363	C-363	C-363		NOT USED
			C-363	Same as C-202
C-364	C-364	C-364		NOT USED
			C-364	CAPACITOR, CERAMIC, DIELECTRIC: 47 μμf ±2.35 μμf 500V, Erie NPO-T
C-401				Same as C-202
	C-401	C-401		Same as C-201
			C-401	NOT USED
C-402				Same as C-201
	C-402	C-402		Same as C-203
			C-402	NOT USED
C-403				Same as C-202
	C-403	C-403		Same as C-201
			C-403	NOT USED
C-404				Same as C-204
	C-404	C-404		Same as C-202
			C-404	NOT USED
C-405				Same as C-202
	C-405	C-405		Same as C-201

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			C-405	NOT USED
C-406*	C-406*	C-406*		CAPACITOR: p/o T-401A
			C-406	NOT USED
C-407	C-407	C-407		Same as C-330
			C-407	NOT USED
C-408	C-408	C-408		Same as C-330
			C-408	NOT USED
C-409*	C-409*	C-409*		CAPACITOR: p/o T-401B
			C-409	NOT USED
C-410*	C-410*	C-410*		CAPACITOR: p/o T-401B
			C-410	NOT USED
C-411				Same as C-202
	C-411	C-411		Same as C-201
			C-411	NOT USED
C-412				Same as C-202
	C-412	C-412		Same as C-201
			C-412	NOT USED
C-413				Same as C-202
	C-413	C-413		Same as C-201
			C-413	NOT USED
C-414				Same as C-201
	C-414	C-414		Same as C-203
			C-414	NOT USED
C-415				Same as C-202
	C-415	C-415		Same as C-201
			C-415	NOT USED
C-416*	C-416*	C-416*		CAPACITOR: p/o T-402A
			C-416	NOT USED
C-417	C-417	C-417		Same as C-330
			C-417	NOT USED
C-418	C-418	C-418		Same as C-330
			C-418	NOT USED
C-419*	C-419*	C-419*		CAPACITOR: p/o T-402B
			C-419	NOT USED
C-420*	C-420*	C-420*		CAPACITOR: p/o T-402B
			C-420	NOT USED
C-421				Same as C-204

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
	C-421	C-421		Same as C-202
			C-421	NOT USED
C-422				Same as C-204
	C-422	C-422		Same as C-202
			C-422	NOT USED
C-423				Same as C-202
	C-423	C-423		Same as C-201
			C-423	NOT USED
C-424				Same as C-201
	C-424	C-424		Same as C-203
			C-424	NOT USED
C-425				Same as C-202
	C-425	C-425		Same as C-201
			C-425	NOT USED
C-426				Same as C-202
	C-426	C-426		Same as C-201
			C-426	NOT USED
C-427*	C-427*	C-427*		CAPACITOR: p/o T-403A
			C-427	NOT USED
C-428	C-428	C-428		Same as C-330
			C-428	NOT USED
C-429	C-429	C-429		CAPACITOR, CERAMIC: 1.2 μμf ±0.1 μμf 500V, Erie NPO-A
			C-429	NOT USED
C-430*	C-430*	C-430*		CAPACITOR: p/o T-403B
			C-430	NOT USED
C-431*	C-431*	C-431*		CAPACITOR: p/o T-403B
			C-431	NOT USED
C-432				Same as C-202
	C-432	C-432		Same as C-201
			C-432	NOT USED
C-433				Same as C-202
	C-433	C-433		Same as C-201
			C-433	NOT USED
C-434				Same as C-204
	C-434	C-434		Same as C-202
			C-434	NOT USED

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
C-435				Same as C-202
	C-435	C-435		Same as C-201
			C-435	NOT USED
C-436				Same as C-204
	C-436	C-436		Same as C-202
			C-436	NOT USED
CR-101	CR-101	CR-101		DIODE, RECTIFIER, SELENIUM: Sarkes-Tarzian 026-30H-QC
			CR-101	DIODE, RECTIFER, SILICON: GE 1N1695
CR-102	CR-102	CR-102		Same as CR-101
			CR-102	Same as CR-101
CR-103	CR-103	CR-103		NOT USED
			CR-103	Same as CR-101
CR-104	CR-104	CR-104		NOT USED
			CR-104	Same as CR-101
CR-105	CR-105	CR-105		NOT USED
			CR-105	DIODE, ZENER, SILICON, DIFFUSED: 10W ±5% Motorola 10M150Z5
CR-106	CR-106	CR-106		NOT USED
			CR-106	DIODE, RECTIFIER: GE 1N1697
CR-107	CR-107	CR-107		NOT USED
			CR-107	Same as CR-106
CR-108	CR-108	CR-108		NOT USED
			CR-108	Same as CR-106
CR-109	CR-109	CR-109		NOT USED
			CR-109	Same as CR-106
CR-110	CR-110	CR-110		NOT USED
			CR-110	Same as CR-106
CR-111	CR-111	CR-111		NOT USED
			CR-111	Same as CR-106
CR-201	CR-201	CR-201	CR-201	DIODE, CRYSTAL, GERMANIUM: Raytheon CK-705/1N66
CR301	CR-301	CR-301		NOT USED
			CR-301	DIODE, SILICON, COMPUTER: Texas Instrument 1N661
DS-101	DS-101			NOT USED
		DS-101	DS-101	LAMP: 6.3V 0.15 amp, miniature bayonet base, GE #47
F-101	F-101	F-101		FUSE: 1 amp, Slo-Blo, Littlefuse 313-001

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			F-101	FUSE, CARTRIDGE: 1 amp Slo-Blo 250V, Bussmann MDL
F-102	F-102	F-102		NOT USED
			F-102	FUSE, CARTRIDGE: 0.5 amp Slo-Blo 250V, Bussmann MDL
J-101	J-101	J-101		CONNECTOR, RECEPTACLE: Hubbell #7486
			J-101	CONNECTOR, RECEPTACLE: Type BNC 1 contact, female, IPC UG-909/U
J-102	J-102	J-102		NOT USED
			J-102	CONNECTOR, RECEPTACLE: 3 contacts, male, 10 amps, flush base, Hubbell #7486
J-201	J-201	J-201		CONNECTOR, RECEPTACLE: UG-291/U
			J-201	CONNECTOR, RECEPTACLE: Type BNC. 1 contact, male, single hole mount, IPC UG-1094/U
J-202	J-202	J-202		CONNECTOR, CABLE, TERMINATION: MX-1684/U
			J-202	FERRULE, RF, CABLE, GROUNDING: lg. o/a 0.813 in. mtg. hole, dia. 0.313 in.
J-203	J-203	J-203		CONNECTOR, CABLE, TERMINATION: MX-1530/U
			J-203	NOT USED
J-301	J-301	J-301		CONNECTOR, RECEPTACLE, RF: UG-1094/U
			J-301	Same as J-201
J-401	J-401	J-401		Same as J-301
			J-401	NOT USED
L-101	L-101	L-101	L-101	NOT USED
L-102	L-102	L-102	L-102	NOT USED
L-103	L-103	L-103		NOT USED
			L-103	INDUCTOR, FILTER: Per Vitro Electronics AA-25,450
L-201				TRANSFORMER, IF: Per Vitro Electronics AB-17,612
	L-201*	L-201*		INDUCTOR: p/o Z-201
			L-201	COIL, RF, VARIABLE: Vitro Electronics AB-32,463
L-202*				INDUCTOR: p/o T-201A
	L-202*	L-202*		INDUCTOR: p/o Z-202
			L-202	CHOKE, RF: 2.8 μh, Vitro Electronics A-16,625
L-203*				INDUCTOR: p/o T-201B
	L-203*	L-203*		INDUCTOR: p/o T-201A
			L-203	Same as L-202
L-204*				INDUCTOR: p/o T-202A
	L-204*	L-204*		INDUCTOR: p/o T-201B

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			L-204	COIL, VARIABLE: Per Vitro Electronics 101, 160 (SDU Type 350-8 only)
L-205*				INDUCTOR: p/o T-202B
	L-205A, B*	L-205A, B*		INDUCTOR: p/o T-202
			L-205	NOT USED
L-206	L-206	L-206		CHOKE, RF: 2. 8 μh, Vitro Electronics A-16, 625
			L-206	NOT USED
L-207	L-207	L-207		Same as L-206
			L-207	NOT USED
L-301	L-301	L-301	L-301	COIL, RF, ADJUSTABLE: 6. 5-10. 6 μh CTC X2060-3
L-302*	L-302*	L-302*		INDUCTOR: p/o Z-301
			L-302	CHOKE, RF: 75 μh, dc resistance 3. 8 Ω, Wilco 1075-15
L-303	L-303	L-303		COIL, RF: Wilco 1075-15
			L-303	Same as L-202
L-304*	L-304*	L-304*		INDUCTOR: p/o T-301
			L-304	CHOKE, RF: 240 μh dc resistance 5. 2 Ω, Wilco 3240-15
L-305*	L-305*	L-305*		INDUCTOR: p/o T-301
			L-305	Same as L-202
L-306*	L-306*	L-306*		INDUCTOR: p/o T-302A
			L-306	Same as L-202
L-307*	L-307*	L-307*		INDUCTOR: p/o T-302B
			L-307	Same as L-202
L-308	L-308	L-308		INDUCTOR COIL: 240 μh, Wilco 3240-15
			L-308	NOT USED
L-309	L-309	L-309		Same as L-206
L-401*	L-401*	L-401*		INDUCTOR: p/o T-401A
			L-401	NOT USED
L-402*	L-402*	L-402*		INDUCTOR: p/o T-401B
			L-402	NOT USED
L-403	L-403	L-403		Same as L-206
			L-403	NOT USED
L-404	L-404	L-404		Same as L-206
			L-404	NOT USED
L-405*	L-405*	L-405*		INDUCTOR: p/o T-402A
			L-405	NOT USED
L-406*	L-406*	L-406*		INDUCTOR: p/o T-402B
			L-406	NOT USED

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
L-407	L-407	L-407		Same as L-206
			L-407	NOT USED
L-408*	L-408*	L-408*		INDUCTOR: p/o T-403A
			L-408	NOT USED
L-409*	L-409*	L-409*		INDUCTOR: p/o T-403B
			L-409	NOT USED
P-101	P-101	P-101		NOT USED
			P-101	CONNECTOR, PLUG, ELECTRICAL: Type BNC, 1 contact, female, IPC UG-260/U
P-201	P-201	P-201		CONNECTOR, PLUG, ELECTRICAL: Type BNC, 1 contact, female, IPC UG-260/U
			P-201	Same as P-101
P-301	P-301	P-301		Same as P-201
			P-301	NOT USED
R-101	R-101	R-101		RESISTOR, VARIABLE, COMPOSITION: 500 Ω ±10% 2W, AB JA1K040S501CU
			R-101	NOT USED
R-102	R-102	R-102		RESISTOR, FIXED, WIREWOUND: 5K ±3% 10W, Dalohm RH-10
			R-102	RESISTOR, FIXED, WIREWOUND: 1.25K ±3% 10W, Dalohm RH-10
R-103	R-103	R-103		RESISTOR, FIXED, COMPOSITION: 47K ±5% 1/2W, AB EB 4735
			R-103	RESISTOR, FIXED, COMPOSITION: 75K ±5% 1/2W, AB HB 7535
R-104	R-104	R-104		Same as R-102
			R-104	Same as R-103
R-105	R-105	R-105		RESISTOR, FIXED, COMPOSITION: 470 Ω ±10% 2W, AB HB 4711
			R-105	RESISTOR, FIXED, COMPOSITION: 1.2 meg ±5% 2W, AB HB 1255
R-106	R-106	R-106		Same as R-102
			R-106	RESISTOR, FIXED, COMPOSITION: 1.8 meg ±10% 1/2W, AB EB 1851
R-107	R-107	R-107		Same as R-105
			R-107	RESISTOR, VARIABLE, COMPOSITION: 1.0 meg ±20% 1/2W, RV5LAYSB105B
R-108	R-108	R-108		RESISTOR, FIXED, COMPOSITION: 10K ±10% 1/2W, AB EB 1031
			R-108	RESISTOR, VARIABLE, COMPOSITION: 500K ±10% 2W AB JA1N048P504UA

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
R-109	R-109	R-109		RESISTOR, VARIABLE, COMPOSITION: 10K ±10% 2W, AB JA1N104P103BA
			R-109	RESISTOR, FIXED, COMPOSITION: 680 Ω ±5% 1/2W, AB EB 6815
R-110	R-110	R-110		RESISTOR, FIXED, COMPOSITION: 1.8 meg ±10% 1/2W, AB EB 1851
			R-110	RESISTOR, VARIABLE, COMPOSITION: 10K ±10% 1/2W, RV51LAYSB103A
R-111	R-111	R-111		RESISTOR, VARIABLE, COMPOSITION: 1 meg ±20% 2W, AB JA1L040S105MC
			R-111	RESISTOR, FIXED, COMPOSITION: 6.8K ±10% 1/2W, AB EB 6821
R-112	R-112	R-112		RESISTOR, VARIABLE, COMPOSITION: 500K ±10% 2W, AB JA1N104P504UA
			R-112	RESISTOR, FIXED, COMPOSITION: 100 Ω ±10% 1/2W, AB EB 1011
R-113	R-113			RESISTOR, FIXED, COMPOSITION: 1.5K ±5% 1/2W, AB EB 1525
		R-113		RESISTOR, FIXED, COMPOSITION: 1.5K ±10% 1/2W, AB EB 1521
			R-113	RESISTOR, FIXED, COMPOSITION: 2 meg ±5% 1/2W, AB EB 2055
R-114	R-114	R-114		RESISTOR, VARIABLE, COMPOSITION: 10K ±10% 2W, AB JA1L040S103UC
			R-114	Same as R-110
R-115	R-115	R-115		RESISTOR, FIXED, COMPOSITION: 6.8K ±10% 1/2W, AB EB 6825
			R-115	RESISTOR, FIXED, COMPOSITION: 150K ±5% 1/2W, AB EB 1545
R-116	R-116	R-116		Same as R-114
			R-116	Same as R-115
R-117	R-117	R-117		RESISTOR, FIXED, COMPOSITION: 100 Ω ±10% 1/2W, AB EB 1011
			R-117	RESISTOR, FIXED, COMPOSITION: 27K ±5% 1/2W, AB EB 2735
R-118	R-118	R-118		RESISTOR, FIXED, COMPOSITION: 2 meg ±5% 1/2W, AB EB 2055
			R-118	RESISTOR, FIXED, COMPOSITION: 470K ±10% 1/2W, AB EB 4841
R-119	R-119	R-119		RESISTOR, FIXED, COMPOSITION: 150K ±5% 1/2W, AB EB 1535
			R-119	RESISTOR, VARIABLE, COMPOSITION: 25K ±10% 1/2W, RV5LAYSB253A

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
R-120	R-120	R-120		Same as R-119
			R-120	Same as R-118
R-121	R-121	R-121		RESISTOR, FIXED, COMPOSITION: 470K ±10% 1/2W, AB EB 4741
			R-121	RESISTOR, FIXED, COMPOSITION: 22K ±5% 1/2W, AB EB 2235
R-122	R-122	R-122		RESISTOR, FIXED, COMPOSITION: 33K ±5% 1/2W, AB EB 3335
			R-122	RESISTOR, FIXED, COMPOSITION: 8.2K ±5% 1/2W, AB EB 8225
R-123	R-123	R-123		Same as R-121
			R-123	Same as R-122
R-124	R-124	R-124		RESISTOR, VARIABLE COMPOSITION: 25K ±10% 2W, AB JA1L040S253UC
			R-124	RESISTOR, FIXED, COMPOSITION: 120K ±5% 1/2W, AB EB 1245
R-125	R-125	R-125		RESISTOR, FIXED, COMPOSITION: 100K ±5% 1/2W, AB EB 1045
			R-125	RESISTOR, VARIABLE COMPOSITION: 500K ±10% 1/2W, RV5LAYSB504A
R-126	R-126	R-126		RESISTOR, FIXED, COMPOSITION: 8.2K ±5% 1/2W, AB EB 8225
			R-126	RESISTOR, FIXED, COMPOSITION: 220K ±5% 1/2W, AB EB 2245
R-127	R-127	R-127		Same as R-126
			R-127	RESISTOR, VARIABLE, COMPOSITION: 100K ±10% 1/2W, linear resistance taper slotted shaft 0.125 in. dia. 0.250 in. lg. beyond bushing, CTS type 65
R-128	R-128	R-128		RESISTOR, FIXED, COMPOSITION: 47K ±5% 1/2W, AB EB 4735
			R-128	RESISTOR, FIXED, COMPOSITION: 560K ±5% 1/2W, AB EB 5645
R-129	R-129	R-129		RESISTOR, VARIABLE, COMPOSITION: 500K ±10% 2W, AB JA1L040S504UC
			R-129	RESISTOR, VARIABLE, COMPOSITION: 500K ±10% 1/2W, linear resistance taper slotted shaft 0.125 in. dia., 0.250 in. lg. beyond bushing, CTS Type 65
R-130	R-130	R-130		RESISTOR, VARIABLE COMPOSITION: 50K ±10% 2W, AB JA1G040P503UA
			R-130	RESISTOR, FIXED, COMPOSITION: 1 meg ±5% 1/2W, AB EB 1055
R-131	R-131	R-131		RESISTOR, FIXED, COMPOSITION: 120K ±10% 1/2W, AB EB 1241

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			R-131	RESISTOR, FIXED, COMPOSITION: 33K ±5% 1/2W, AB EB 3335
R-132	R-132	R-132		RESISTOR, FIXED, COMPOSITION: 56K ±10% 1/2W, AB EB 5631
			R-132	RESISTOR, VARIABLE, COMPOSITION: 5K ±10% 1/2W RV5LAYSB502A
R-133	R-133	R-133		RESISTOR, VARIABLE, COMPOSITION: 250K ±10% 2W AB JA1G040P254UA
			R-133	RESISTOR, FIXED, COMPOSITION: 100K ±5% 1/2W, AB EB 1045
R-134	R-134	R-134		RESISTOR, FIXED, COMPOSITION: 330K ±10% 1W, AB GB 3341
			R-134	RESISTOR, FIXED, COMPOSITION: 470 Ω ±5% 1/2W, AB EB 4715
R-135	R-135	R-135		RESISTOR, FIXED, COMPOSITION: 160K ±5% 1W, AB GB 1645
			R-135	RESISTOR, FIXED, COMPOSITION: 1K ±5% 1/2W, AB EB 1025
R-136	R-136	R-136		RESISTOR, VARIABLE, COMPOSITION: 5K ±10% 2W, AB JA1L040S502UC
			R-136	Same as R-133
R-137	R-137	R-137		RESISTOR, FIXED, COMPOSITION: 36K ±5% 1/2W, AB EB 3635
			R-137	Same as R-133
R-138	R-138	R-138		Same as R-121
			R-138	RESISTOR, FIXED, COMPOSITION: 24K ±5% 1/2W, AB EB 1045
R-139	R-139	R-139		Same as R-125
			R-139	RESISTOR, FIXED, COMPOSITION: 10K ±5% 1/2W, AB EB 1035
R-140	R-140	R-140		Same as R-125
			R-140	RESISTOR, VARIABLE, COMPOSITION: 10K ±10% 2W, JA1N048P103UA
R-141	R-141	R-141		RESISTOR, FIXED, COMPOSITION: 27K ±5% 1/2W, AB EB 2735
			R-141	RESISTOR, FIXED, COMPOSITION: 10 meg ±5% 1/2W, AB EB 1065
R-142	R-142	R-142		Same as R-108
			R-142	Same as R-141
R-143	R-143	R-143		NOT USED
			R-143	Same as R-141
R-144	R-144	R-144		NOT USED

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			R-144	Same as R-141
R-145	R-145	R-145		NOT USED
			R-145	Same as R-141
R-146	R-146	R-146		NOT USED
			R-146	Same as R-141
R-201				RESISTOR, FIXED, COMPOSITION: 3.0K ±5% 1/2W, AB EB 3025 (SDU-Type 300-1)
				RESISTOR, FIXED, COMPOSITION: 4.7K ±5% 1/2W, AB EB 4725 (SDU-Type 200-1)
				RESISTOR, FIXED, COMPOSITION: 2.7K ±5% 1/2W, AB EB 2725 (SDU-Types 200-2, 200-7, 300-4)
				RESISTOR, FIXED, COMPOSITION: 8.2K ±5% 1/2W, AB EB 8225 (SDU-Type 300-6)
	R-201	R-201		RESISTOR, FIXED, COMPOSITION: 3.3K ±5% 1/2W, AB EB 3325
			R-201	RESISTOR, FIXED, COMPOSITION: 36K ±5% 1/2W, AB EB 3635 (SDU-Type 350-6 only)
				RESISTOR, FIXED, COMPOSITION: 5.6K ±5% 1/2W, AB EB 5625 (SDU-Type 350-7)
				RESISTOR, FIXED, COMPOSITION: 33K ±5% 1/2W, AB EB AB EB 3335 (SDU-Type 350-8)
R-202	R-202	R-202	R-202	RESISTOR, FIXED, COMPOSITION: 130 Ω ±5% 1/2W, AB EB 1315
R-203	R-203	R-203	R-203	RESISTOR, FIXED, COMPOSITION: 33 Ω ±5% 1/2W, AB EB 3305
R-204	R-204	R-204		RESISTOR, FIXED, COMPOSITION: 24K ±5% 1/2W, AB EB 2435
			R-204	Same as R-138
R-205*				RESISTOR: p/o T-201A
	R-205	R-205		RESISTOR, FIXED, COMPOSITION: 100 Ω ±5% 1/2W, AB EB 1015
			R-205*	RESISTOR: p/o T-201
R-206				RESISTOR, FIXED, COMPOSITION: 100 Ω ±10% 1/2W, AB EB 1011
	R-206*	R-206*		RESISTOR: p/o Z-202
			R-206	Same as R-112
R-207				RESISTOR, FIXED, COMPOSITION: 47K ±5% 1/2W, AB EB 4735 (SDU-Type 300-1)
				RESISTOR, FIXED, COMPOSITION: 33K ±5% 1/2W, AB EB 3335 (SDU-Type 300-4)
				RESISTOR, FIXED, COMPOSITION: 16K ±5% 1/2W, AB EB 1635 (SDU-Type 200-1)

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
				RESISTOR, FIXED, COMPOSITION: 27K ±5% 1/2W; AB EB 2735 (SDU-Type 300-6)
	R-207	R-207		RESISTOR, FIXED, COMPOSITION: 3K ±5% 1/2W, AB EB 3025
			R-207	RESISTOR, FIXED, COMPOSITION: 2.2K ±5% 1/2W, AB EB 2225 (SDU-Type 350-6 only)
				RESISTOR, FIXED, COMPOSITION: 2K ±5% 1/2W, AB EB 2025 (SDU-Type 350-8)
				RESISTOR, FIXED, COMPOSITION: 47K ±5% 1/2W, AB EB 4735 (SDU-Type 350-7)
R-208	R-208	R-208	R-208	RESISTOR, FIXED, COMPOSITION: 390 Ω ±5% 1/2W, AB EB 3025
R-209	R-209	R-209	R-209	RESISTOR, FIXED, COMPOSITION: 39K ±5% 1/2W, AB EB 3935
R-210*				RESISTOR: p/o T-202A
	R-210*	R-210*		RESISTOR: p/o T-201A
			R-210*	RESISTOR: p/o T-203
R-211				RESISTOR, FIXED, COMPOSITION: 2.0K ±5% 1/2W, AB EB 2025 (SDU-Type 200-1)
				RESISTOR, FIXED, COMPOSITION: 2.7K ±5% 1/2W, AB EB 2725 (SDU-Type 300-1)
				RESISTOR, FIXED, COMPOSITION: 4.3K ±5% 1/2W, AB EB 4325 (SDU-Types 200-2, 200-7)
				RESISTOR, FIXED, COMPOSITION: 2.4K ±5% 1/2W, AB EB 2425 (SDU-Type 300-4)
				RESISTOR, FIXED, COMPOSITION: 820 Ω ±5% 1/2W, AB EB 8215 (SDU-Type 300-6)
	R-211			RESISTOR, FIXED, COMPOSITION: 15K ±5% 1/2W, AB EB 1505
		R-211		RESISTOR, FIXED, COMPOSITION: 2.4K ±5% 1/2W, AB EB 2425
			R-211	RESISTOR, FIXED, COMPOSITION: 2K ±5% 1/2W, AB EB 2025 (SDU-Type 350-7)
				RESISTOR, FIXED, COMPOSITION: 2.2K ±5% 1/2W, AB EB 2225 (SDU-Type 350-8)
				RESISTOR, FIXED, COMPOSITION: 1.3K ±5% 1/2W, AB EB 1325 (SDU-Type 350-6 only)
R-212	R-212	R-212	R-212	Same as R-208
R-213	R-213	R-213	R-213	Same as R-209
R-214*				RESISTOR: p/o T-203
	R-214*	R-214*		RESISTOR: p/o T-202
			R-214*	RESISTOR: p/o T-205

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
R-215				RESISTOR, FIXED, COMPOSITION: 47K ±10% 1/2W, AB EB 4731
	R-215	R-215		Same as R-103
			R-215	Same as R-135
R-216				Same as R-215
	R-216	R-216		Same as R-103
			R-216	RESISTOR, FIXED, COMPOSITION: 47K ±5% 1/2W, AB EB 4735
R-217	R-217			RESISTOR, FIXED, COMPOSITION: 1K ±10% 1/2W, AB EB 1021
		R-217		RESISTOR, FIXED, COMPOSITION: 1K ±5% 1/2W, AB EB 1025
			R-217	Same as R-216
R-218				NOT USED (SDU-Types 200-1, 200-2, 200-7, 300-1, 300-4)
				RESISTOR, FIXED, COMPOSITION: 43K ±5% 1/2W, AB EB 3325 (SDU-Type 300-6)
	R-218	R-218	R-218	NOT USED
R-219	R-219	R-219		NOT USED
			R-219	RESISTOR, FIXED, COMPOSITION: 3.3K ±5% 1/2W, AB EB 3325 (SDU-Type 300-8 only)
				NOT USED (SDU-Types 350-6, 350-7)
R-301	R-301	R-301		Same as R-108
			R-301	RESISTOR, FIXED, COMPOSITION: 10K ±10% 1/2W, AB EB 1031
R-302	R-302	R-302	R-302	RESISTOR, FIXED, COMPOSITION: 330 Ω ±5% 1/2W, AB EB 3315
R-303	R-303	R-303		Same as R-117
			R-303	Same as R-112
R-304	R-304	R-304		RESISTOR, FIXED, COMPOSITION: 1K ±10% 1/2W, AB EB 1021
			R-304	Same as R-135
R-305	R-305	R-305		Same as R-304
			R-305	Same as R-138
R-306	R-306	R-306		Same as R-204
			R-306	Same as R-135
R-307	R-307	R-307		Same as R-304
			R-307	Same as R-135
R-308*	R-308*	R-308*		RESISTOR: p/o T-301

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			R-308	RESISTOR, FIXED, COMPOSITION: 2.4K ±5% 1/2W, AB EB 2425
R-309	R-309	R-309		RESISTOR, FIXED, COMPOSITION: 150 Ω ±10% 1/2W, AB EB 1511
			R-309	Same as R-133
R-310	R-310	R-310		Same as R-115
			R-310	Same as R-133
R-311*	R-311*	R-311*		RESISTOR: p/o T-302A
			R-311	RESISTOR, FIXED, COMPOSITION: 1 meg ±5% 1/2W, AB EB 1055
R-312*	R-312*	R-312*		RESISTOR: p/o T-302B
			R-312	RESISTOR, FIXED, COMPOSITION: 150 Ω ±10% 1/2W, AB EB 1511
R-313	R-313	R-313		RESISTOR, FIXED, COMPOSITION: 270 Ω ±10% 1/2W, AB EB 2711
			R-313	Same as R-111
R-314	R-314			Same as R-125
		R-314		RESISTOR, FIXED, COMPOSITION: 100K ±10% 1/2W, AB EB 1041
			R-314*	RESISTOR: p/o T-303
R-315	R-315			Same as R-125
		R-315		Same as R-314
			R-315*	RESISTOR: p/o T-304
R-316	R-316	R-316		RESISTOR, FIXED, COMPOSITION: 1 meg ±5% 1/2W, AB EB 1055
			R-316	Same as R-130
R-317	R-317	R-317		NOT USED
			R-317	Same as R-203
R-318	R-318	R-318		NOT USED
			R-318	Same as R-112
R-319	R-319	R-319		NOT USED
			R-319	Same as R-138
R-320	R-320	R-320		NOT USED
			R-320*	RESISTOR: p/o T-305
R-321	R-321	R-321		NOT USED
			R-321*	RESISTOR: p/o T-306
R-322	R-322	R-322		NOT USED
			R-322	Same as R-203
R-323	R-323	R-323		NOT USED

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			R-323	Same as R-112
R-324	R-324	R-324		NOT USED
			R-324	Same as R-138
R-325	R-325	R-325		NOT USED
			R-325*	RESISTOR: p/o T-307
R-326	R-326	R-326		NOT USED
			R-326	RESISTOR, FIXED, COMPOSITION: 270 Ω ±10% 1/2W, AB EB 2711
R-327	R-327	R-327		NOT USED
			R-327*	RESISTOR: p/o T-308
R-328	R-328	R-328		NOT USED
			R-328	Same as R-208
R-329	R-329	R-329		NOT USED
			R-329	Same as R-209
R-330	R-330	R-330		NOT USED
			R-330	Same as R-326
R-331	R-331	R-331		NOT USED
			R-331*	RESISTOR: p/o T-309
R-332	R-332	R-332		NOT USED
			R-332	Same as R-301
R-333	R-333	R-333		NOT USED
			R-333*	RESISTOR: p/o T-310
R-334	R-334	R-334		NOT USED
			R-334*	RESISTOR: p/o T-310
R-335	R-335	R-335	R-335	NOT USED
R-336	R-336	R-336		NOT USED
			R-336	Same as R-126
R-337	R-337	R-337		NOT USED
			R-337	RESISTOR, VARIABLE, COMPOSITION: 500 Ω ±10% 1/2W, RV5LAYSB501A
R-401	R-401			Same as R-117
		R-401		Same as R-205
			R-401	NOT USED
R-402	R-402	R-402		RESISTOR, FIXED, COMPOSITION: 33 Ω ±10% 1/2W, AB EB 3301
			R-402	NOT USED
R-403	R-403	R-403		Same as R-204

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			R-403	NOT USED
R-404	R-404	R-404		Same as R-402
			R-404	NOT USED
R-405*	R-405*	R-405*		RESISTOR: p/o T-401A
			R-405	NOT USED
R-406*	R-406*	R-406*		RESISTOR: p/o T-401B
			R-406	NOT USED
R-407	R-407			Same as R-117
		R-407		Same as R-205
			R-407	NOT USED
R-408	R-408	R-408		Same as R-204
			R-408	NOT USED
R-409*	R-409*	R-409*		RESISTOR: p/o T-402A
			R-409	NOT USED
R-410	R-410	R-410		Same as R-313
			R-410	NOT USED
R-411*	R-411*	R-411*		RESISTOR: p/o T-402B
			R-411	NOT USED
R-412	R-412	R-412		Same as R-208
			R-412	NOT USED
R-413	R-413	R-413		Same as R-209
			R-413	NOT USED
R-414*	R-414*	R-414*		RESISTOR: p/o T-403A
			R-414	NOT USED
R-415	R-415	R-415		Same as R-313
			R-415	NOT USED
R-416	R-416	R-416		Same as R-108
			R-416	NOT USED
R-417	R-417	R-417		RESISTOR, FIXED, COMPOSITION: 4.7 Ω ±10% 1W
			R-417	NOT USED
R-418*	R-418*	R-418*		RESISTOR: p/o T-403B
			R-418	NOT USED
R-419*	R-419*	R-419*		RESISTOR: p/o T-403B
			R-419	NOT USED
R-420	R-420	R-420		RESISTOR, FIXED, COMPOSITION: 220K ±10% 1/2W, AB EB 2241

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
			R-420	NOT USED
R-421	R-421			Same as R-316
		R-421		RESISTOR, FIXED, COMPOSITION: 1 meg ±10% 1/2W, AB EB 1051
			R-421	NOT USED
S-101	S-101	S-101	S-101	SWITCH, TOGGLE: Intermediate size bat lever, SPST, 3 amps, 250V, H. H. Smith #520
S-102	S-102	S-102		NOT USED
			S-102	SWITCH, TOGGLE: Intermediate size bat lever, DPDT 3 amps, 250V, H. H. Smith #523
T-101	T-101	T-101		TRANSFORMER, POWER: Vitro Electronics AC-17,745.
			T-101	TRANSFORMER, POWER: Vitro Electronics AA-25,451
T-102	T-102	T-102		TRANSFORMER, OUTPUT: Vitro Electronics AB-17,744
			T-102	OSCILLATOR ASSEMBLY BLOCKING: Vitro Electronics AA-26,624
T-201A		T-201A		TRANSFORMER, IF: Vitro Electronics AB-17,614
	T-201A			TRANSFORMER, IF: Vitro Electronics AB-17,989
			T-201	TRANSFORMER, IF: Vitro Electronics AB-32,466
T-201B				TRANSFORMER, IF: Vitro Electronics AB-17,613
	T-201B			TRANSFORMER, IF: Vitro Electronics AB-17,987
		T-201B		TRANSFORMER, IF: Vitro Electronics AB-17,615
T-202A				Same as T-201A
	T-202			TRANSFORMER, IF: Vitro Electronics AB-17,985
		T-202		TRANSFORMER, IF: Vitro Electronics AB-17,611
			T-202	TRANSFORMER, IF: Vitro Electronics AB-32,464 (SDU-Types 350-6, 350-7 only)
				TRANSFORMER, IF: Vitro Electronics 101,161-01 (SDU-Type 350-8 only)
T-202B				TRANSFORMER, IF: Vitro Electronics AB-17,615
T-203				TRANSFORMER, IF: Vitro Electronics AB-17,611
	T-203	T-203		NOT USED
			T-203	Same as T-201
T-204	T-204	T-204		NOT USED
			T-204	TRANSFORMER, IF: Vitro Electronics AB-32,465
T-205	T-205	T-205		NOT USED
			T-205	TRANSFORMER, IF: Vitro Electronics AB-32,467

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
T-301	T-301	T-301		TRANSFORMER, IF: Vitro Electronics AB-17,910
			T-301	TRANSFORMER, IF: Vitro Electronics AB-32,461
T-302A	T-302A	T-302A		TRANSFORMER, IF: Vitro Electronics AB-17,910
			T-302A,B	TRANSFORMER, IF: Vitro Electronics AB-32,487
T-302B	T-302B	T-302B		TRANSFORMER, IF: Vitro Electronics AB-17,533
T-303	T-303	T-303		NOT USED
			T-303	TRANSFORMER, IF: Vitro Electronics AB-32,474
T-304	T-304	T-304		NOT USED
			T-304	TRANSFORMER, IF: Vitro Electronics AB-32,476
T-305	T-305	T-305		NOT USED
			T-305	Same as T-303
T-306	T-306	T-306		NOT USED
			T-306	Same as T-304
T-307	T-307	T-307		NOT USED
			T-307	Same as T-303
T-308	T-308	T-308		NOT USED
			T-308	Same as T-304
T-309	T-309	T-309		NOT USED
			T-309	Same as T-303
T-310	T-310	T-310		NOT USED
			T-310	TRANSFORMER, IF: Vitro Electronics AB-32,469
T-401A	T-401A	T-401A		Same as T-301A
			T-401	NOT USED
T-401B	T-401B	T-401B		Same as T-302B
			T-402	NOT USED
T-402A	T-402A	T-402A		Same as T-302A
T-402B	T-402B	T-402B		Same as T-302B
T-403A	T-403A	T-403A		Same as T-302A
			T-403	NOT USED
T-403B	T-403B	T-403B		TRANSFORMER, IF: Vitro Electronics AB-17,624
V-101	V-101	V-101		TUBE, ELECTRON: 5Y3GT
			V-101	TUBE, ELECTRON: 5670
V-102	V-102	V-102		TUBE, ELECTRON: OA2
			V-102	Same as V-101
V-103	V-103	V-103		Same as V-102
			V-103	Same as V-101

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
V-104	V-104	V-104		TUBE, ELECTRON: 12AU7
			V-104	TUBE, ELECTRON: CRT Type 3XP1
V-105	V-105	V-105		TUBE, ELECTRON: 12AT7
			V-105	NOT USED
V-106	V-106	V-106		TUBE, ELECTRON: CRT Type 3RP1A
			V-106	NOT USED
V-107	V-107	V-107		Same as V-105
			V-107	NOT USED
V-201	V-201	V-201	V-201	TUBE, ELECTRON: 6BA6
V-202	V-202	V-202	V-202	TUBE, ELECTRON: 6AU6
V-203	V-203	V-203	V-203	Same as V-202
V-301	V-301	V-301	V-301	TUBE, ELECTRON 6AH6
V-302	V-302	V-302	V-302	Same as V-202
V-303	V-303	V-303	V-303	TUBE, ELECTRON: 6BE6
V-304	V-304	V-304		NOT USED
			V-304	Same as V-201
V-305	V-305	V-305		NOT USED
			V-305	Same as V-201
V-306	V-306	V-306		NOT USED
			V-306	Same as V-202
V-401	V-401	V-401		Same as V-201
			V-401	NOT USED
V-402	V-402	V-402		Same as V-201
			V-402	NOT USED
V-403	V-403	V-403		Same as V-202
			V-403	NOT USED
V-404	V-404	V-404		TUBE, ELECTRON: 6AL5
			V-404	NOT USED
XDS-101	XDS-101			NOT USED
		XDS-101	XDS-101	LAMPHOLDER: Bussmann HKP
XI-101	XI-101			LAMPHOLDER: Bussmann HKP
		XI-101	XI-101	NOT USED
	Z-201	Z-201		FILTER, IF, INPUT: Vitro Electronics AB-17,612
Z-201			Z-201	NOT USED
		Z-202		FILTER, IF, INTERSTAGE: Vitro Electronics AB-31,281
Z-202			Z-202	NOT USED

REPLACEMENT PARTS LIST -- Continued

Subtype A	Subtype B	Subtype C	Subtype D	DESCRIPTION
	Z-202			FILTER, IF, INTERSTAGE: Vitro Electronics AB-17, 986
			Z-301	NOT USED
Z-301	Z-301	Z-301		OSCILLATOR COIL: Vitro Electronics AB-17, 909

* NOT SEPARATELY REPLACEABLE

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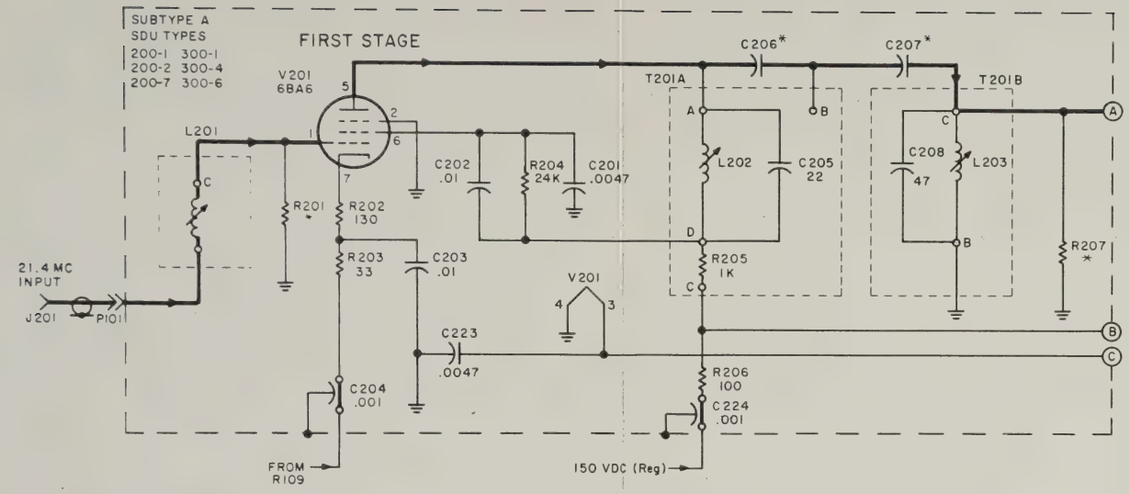

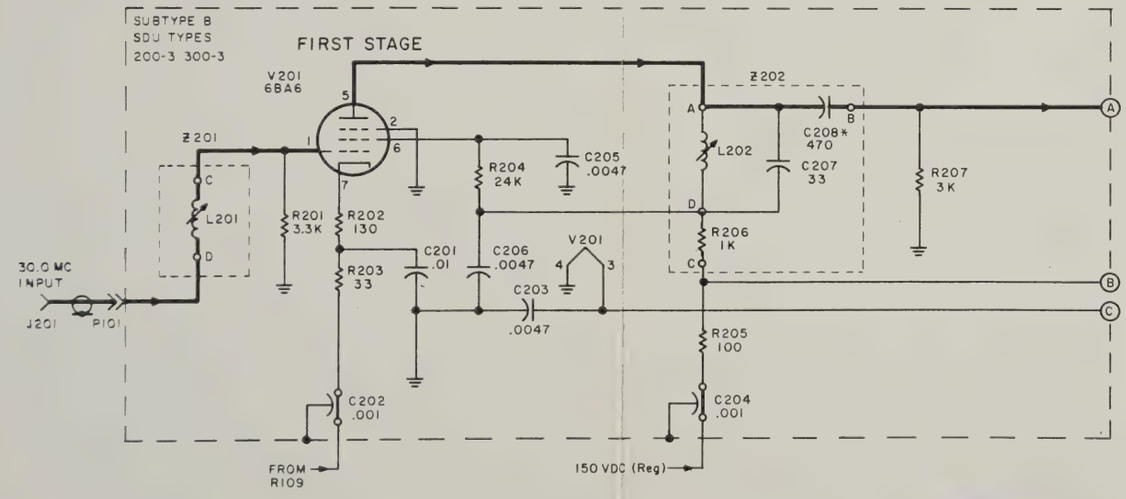

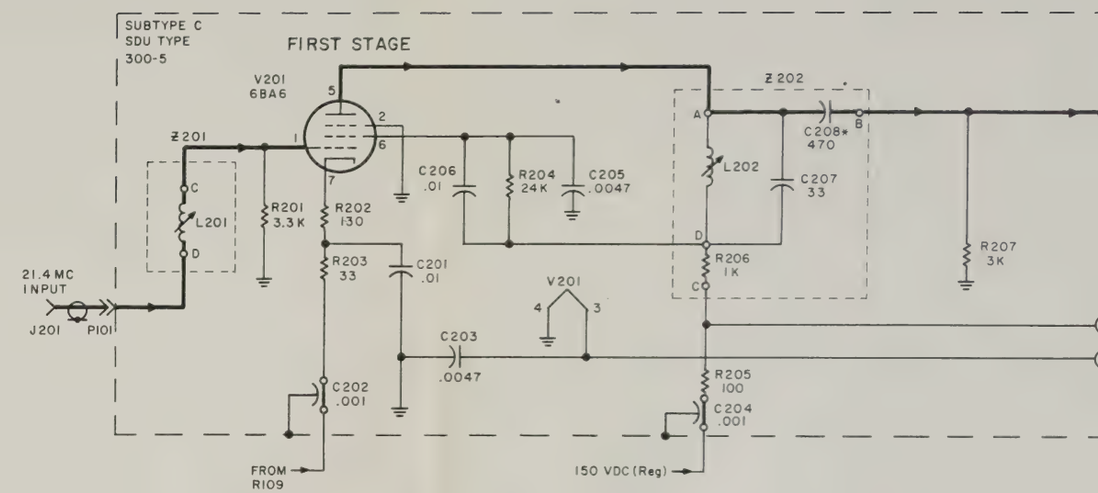

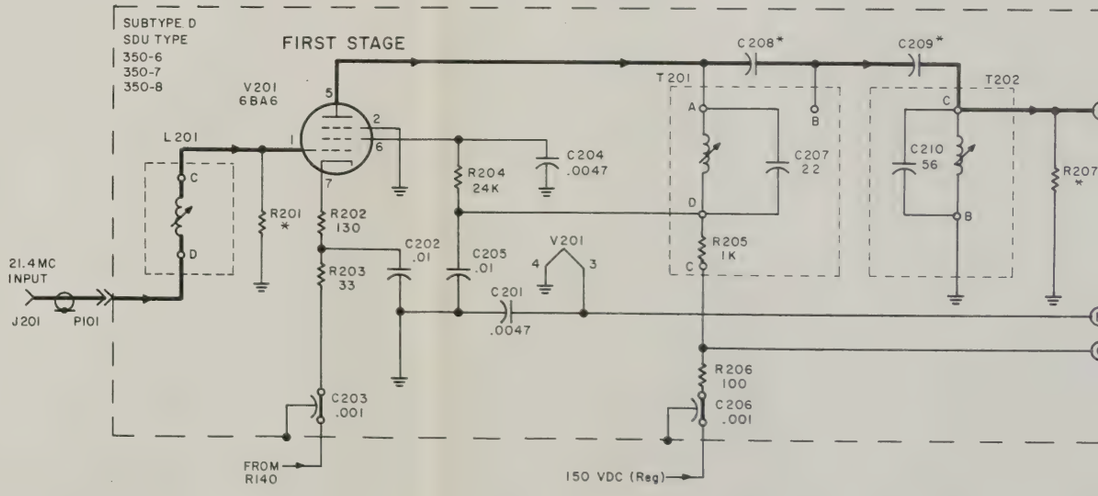

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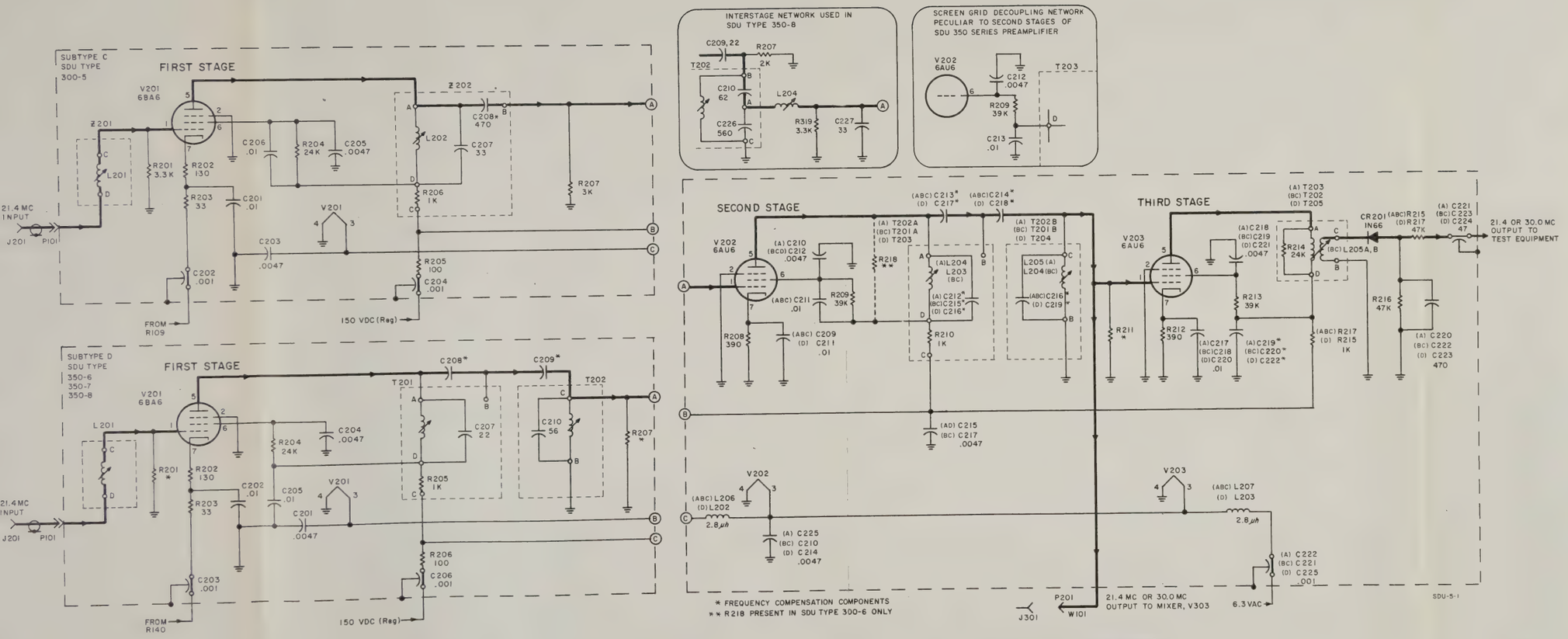

PREAMPLIFIER COMPONENT VALUES

	SUBTYPE A						SUBTYPE B		SUB-TYPE C	SUBTYPE D		
	200-1	200-2	200-7	300-1	300-4	300-6	200-3	300-3	300-5	350-6	350-7	350-8
C206	10	10	10	15	15	15						
C207	15	12	10	22	22	22						
C208										18	8.2	18
C209										22	8.2	22
C213	10	6.8	6.8	10	10	12	10	10	22			
C214	10	10	10	18	18	15	10	10	18			
C217										18	8.2	18
C218										18	8.2	18
C219	.01	.01	.01	01	01	.01						
C220							4700	4700	01			
C222										01	.01	.01
C227												33
R201	4.7K	2.7K	2.7K	3.0K	2.7K	8.2K				36K	5.6K	33K
R207	16K			47K	33K	27K				2.2K	47K	2.0K
R211	2.0K	4.3K	4.3K	2.7K	2.4K	820	15K	15K	2.4K	1.3K	2.0K	2.2K
R218						43K						
R219												3.3K

NOTE:
1. UNLESS OTHERWISE SPECIFIED:
   A. RESISTORS ARE MEASURED IN OHMS, K=1000 MEG=1,000,000.
   B. CAPACITOR VALUES 1.0 AND OVER ARE IN μμf AND CAPACITOR VALUES UNDER 1.0 ARE IN μf.
   C. HEAVY LINES INDICATE MAIN SIGNAL PATHS.

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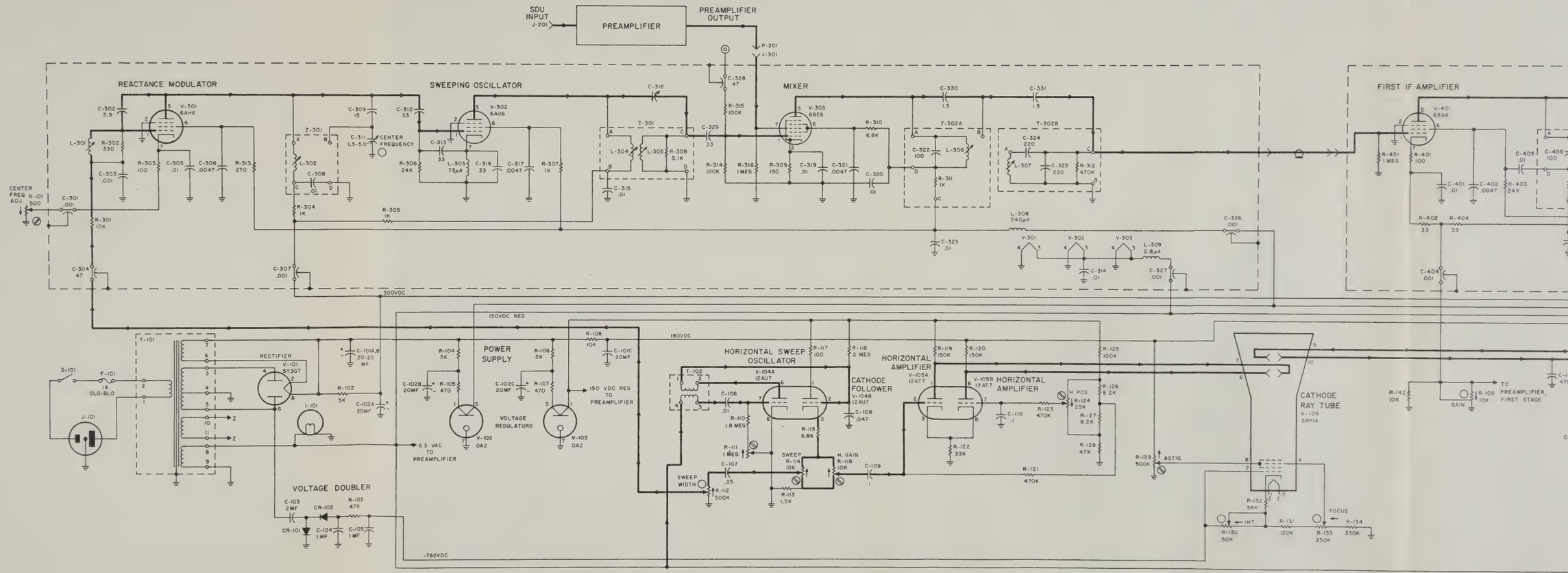
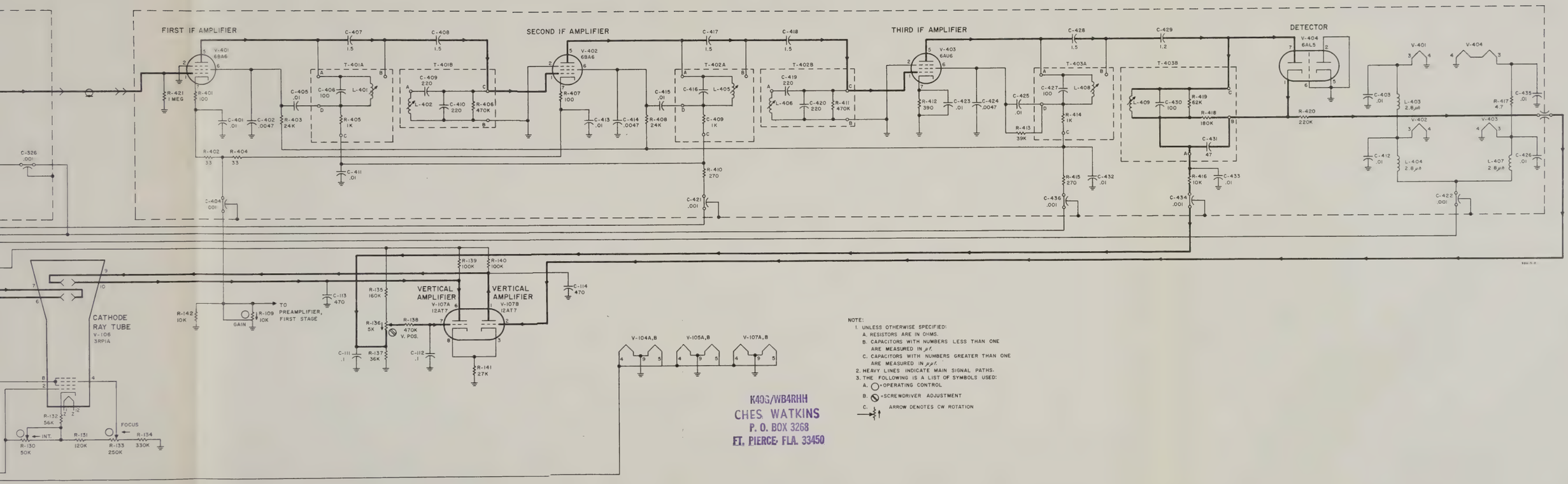
Figure 5–1. Spectrum Display Unit, Composite Schematic Diagram of Preamplifiers


SDU INPUT J-201
PREAMPLIFIER
PREAMPLIFIER OUTPUT
P-201
J-301
REACTANCE MODULATOR
SWEEPING OSCILLATOR
MIXER
FIRST IF AMPLIFIER
CENTER FREQ ADJ.
300VDC
150VDC REG
180VDC
RECTIFIER
POWER SUPPLY
VOLTAGE REGULATORS
VOLTAGE DOUBLER
HORIZONTAL SWEEP OSCILLATOR
CATHODE FOLLOWER
HORIZONTAL AMPLIFIER
CATHODE RAY TUBE
6.3 VAC TO PREAMPLIFIER
150 VDC REG TO PREAMPLIFIER
TO PREAMPLIFIER, FIRST STAGE
-760VDC



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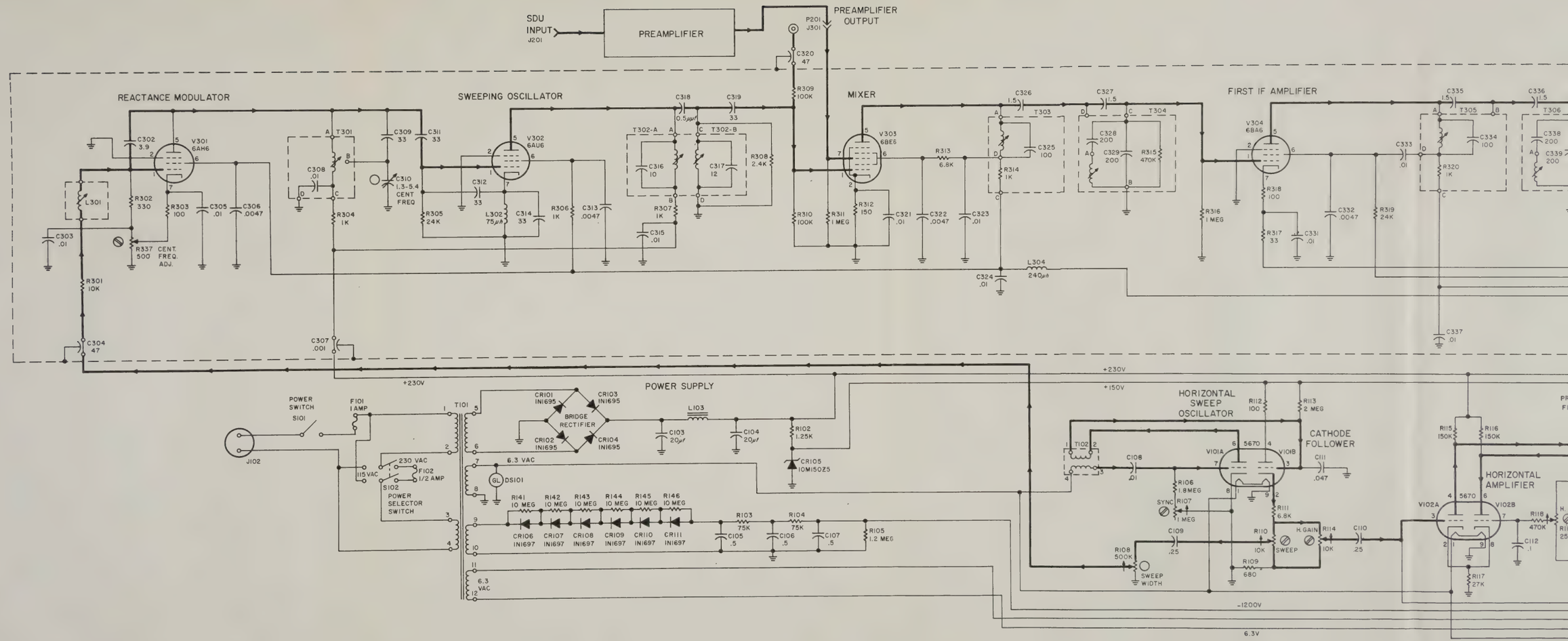
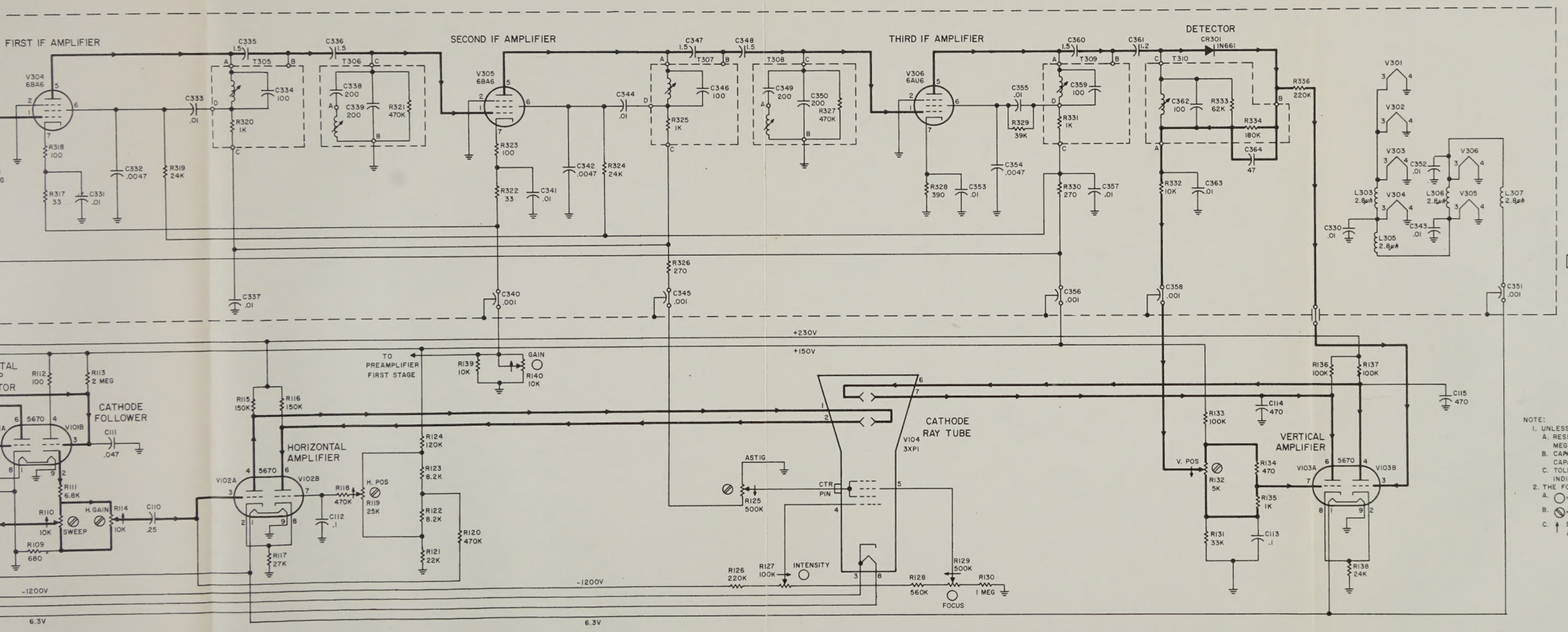
FT. PIERCE, FLA. 33450

Figure 5–2. Spectrum Display Unit, Types 200 and 300, Schematic Diagram of Main Chassis


SDU INPUT J201
PREAMPLIFIER
P201 J301
PREAMPLIFIER OUTPUT
C320 47
R309 100K
REACTANCE MODULATOR
SWEEPING OSCILLATOR
MIXER
FIRST IF AMPLIFIER
V301 6AH6
V302 6AU6
V303 6BE6
V304 6BA6
T301
T302-A
T302-B
T303
T304
T305
T306
L301
L302 75μh
L303 240μh
L304 240μh
R301 10K
R302 330
R303 100
R304 1K
R305 24K
R306 1K
R307 1K
R308 2.4K
R310 100K
R311 1 MEG
R312 150
R313 6.8K
R314 1K
R315 470K
R316 1 MEG
R317 33
R318 100
R319 24K
R320 1K
C302 3.9
C303 .01
C304 47
C305 .01
C306 .0047
C307 .001
C308 .01
C309 33
C310 1.3-5.4 CENT FREQ
C311 33
C312 33
C313 .0047
C314 33
C315 .01
C316 10
C317 12
C318 0.5μμf
C319 33
C321 .01
C322 .0047
C323 .01
C324 .01
C325 100
C326 1.5
C327 1.5
C328 200
C329 200
C331 .01
C332 .0047
C333 .01
C334 100
C335 1.5
C336 1.5
C337 .01
C338 200
C339 200
R337 500 CENT. FREQ. ADJ.
+230V
+150V
-1200V
6.3V
POWER SUPPLY
POWER SWITCH S101
F101 1 AMP
J102
T101
230 VAC
115 VAC
F102 1/2 AMP
S102 POWER SELECTOR SWITCH
6.3 VAC
DS101
CR101 IN1695
CR102 IN1695
CR103 IN1695
CR104 IN1695
BRIDGE RECTIFIER
CR105 10MI50Z5
L103
C103 20μf
C104 20μf
R102 1.25K
R103 75K
R104 75K
R105 1.2 MEG
C105 .5
C106 .5
C107 .5
R141 10 MEG
R142 10 MEG
R143 10 MEG
R144 10 MEG
R145 10 MEG
R146 10 MEG
CR106 IN1697
CR107 IN1697
CR108 IN1697
CR109 IN1697
CR110 IN1697
CR111 IN1697
HORIZONTAL SWEEP OSCILLATOR
CATHODE FOLLOWER
HORIZONTAL AMPLIFIER
V101A
V101B
V102A
V102B
5670
T102
R106 1.8MEG
R107 1 MEG
SYNC
R108 500K
SWEEP WIDTH
R109 680
R110 10K
SWEEP
R111 6.8K
R112 100
R113 2 MEG
R114 10K
H. GAIN
R115 150K
R116 150K
R117 27K
R118 470K
C108 .01
C109 .25
C110 .25
C111 .047
C112 .1



NOTE:
1. UNLESS OTHERWISE SPECIFIED:
   A. RESISTORS ARE MEASURED IN OHMS. K=1000 OHMS; MEG=1,000,000 OHMS.
   B. CAPACITOR VALUES 1.0 AND OVER ARE IN μμf AND CAPACITOR VALUES UNDER 1.0 ARE IN μf.
   C. TOLERANCES OR RATINGS ON COMPONENTS ARE NOT INDICATED.
2. THE FOLLOWING IS A LIST OF SYMBOLS USED:
   A. ◯ = KNOB ADJUST
   B. ⊘ = SCREWDRIVER ADJUST
   C. ↑ DENOTES CLOCKWISE ROTATION AS VIEWED FROM ADJUSTMENT END.

SDU-5-3

Figure 5–3. Spectrum Display Unit, Type 350, Schematic Diagram of Main Chassis

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PCM Signal Simulators
Dataphone Interface Equipment
Voltage Controlled Oscillator Calibrator

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Collimation Transmitters
Boresight Transmitters
FM/FM Simulators (Data Insertion Converters
PCM Bit Synchronizer Error Analyzers

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Radar Test Set Systems
Missile Cradles
Radio Sets
Teletype Accessories

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Medical Data Systems
Telemetry Data Systems
Predetection Recording Systems
Analog-to-Digital Recording Systems
Analog Recording Systems
Monopulse Antenna Tracking Systems
Conical Scan Antenna Tracking Systems
Surveillance Receiving/Recording and Display Systems
Communications Systems
Mobile Air Transportable Van Mounted Systems
Airborne Receiving Systems
Pre & Post Detection Recording and Diversity Combining Systems
Computer Input Buffer Systems
Transponder Systems
Remote Controlled Data Acquisition System
Computer Controlled PCM Ground and FM/FM Data Acquisition Systems

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